UNDERSTANDING LEARNING AND TEACHING: AN INVESTIGATION OF PUPIL EXPERIENCE OF CONTENT IN RELATION TO IMMEDIATE AND LONG-TERM LEARNING

A thesis
submitted in fulfilment
of the requirement for the Degree
of
Doctor of Philosophy
in the
University of Canterbury
by

A. G. Alton-Lee

University of Canterbury
1984

TO

Stuart and Amity

...to make an end is to

make a beginning.

(T. S. Eliot, The Four Quartets)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

This thesis was possible because Professor Graham Nuthall provided me with the freedom to take a risk and break with traditions past and present. His support has been sensitive, tolerant, generous, and steadfast. His academic leadership has been a constant challenge. I value the hours of brainstorm, argument, and discovery as a special privilege in my lifetime.

I am also indebted to Robin Haberfield for allowing me to come into his classroom and carry out this study. Robin's integrity and achievement as a teacher make this thesis worth reading just for the account of an impressive programme.

There are so many people who have made unique contributions to this thesis. I cannot adequately thank John Batstone for his ongoing support and inspiration. His wisdom, professional insight, and generosity have helped raise the standard of the conception and writing of this thesis. I am deeply grateful to Christine Tremewan for her unflagging support and selfless encouragement at the most difficult hours. Without the financial assistance and emotional support of my mother, Valmai Welsford, this thesis would not have been possible. I am especially grateful to Prue Densem for her never-failing faith in, and encouragement of, this research.

I am grateful for the long and demanding hours of observation carried out by Gay Peak and Jacqui Dyer. I am also grateful to Moira for her help with the difficult task of transcribing.

To my colleagues at Christchurch Teachers College I am grateful for cheerful, continuing support. John Patrick, Jeanne Biddulph, Geoff Price, Ron Stevens, Roger Murdoch, and Neil Anderson - thank you! This thesis has been enriched by

my experiences working with you all. I am also grateful to Euan Hundleby and Ian Stewart for their professional support for this research.

Fred Biddulph has provided continuing support in a stream of relevant papers. His central concern with research into children's learning has been inspirational. I am indebted to him for his challenges to, and his faith in, this research.

To the staff of the University of Canterbury Education Department, past and present, Katherine Baird, Ivan Snook, Brian Haig, Bryan Tuck, Jenny Young Loveridge, John Small, Marie Shand, Jan Vincent-Smith, Bob Manthei, Colin McGeorge, Warwick Elley, and John Church, for support in so many ways - thank you! I would not have survived the final stages without the generosity and efficiency of Joan Earl.

Roger Corbett, for your skill and kindness - thank you! Thank you especially to Dot, Gillian Finegan, and all at the computer centre. It must take a rare kind of patience to work with tired Ph.D students.

I am especially grateful to Stephen Proctor for his keen insight, and encouragement, and his willingness to explore ideas in relation to his own teaching. I am fortunate to have experienced Vivien Proctor's gentleness, wisdom and support.

To Claire Hobden, for taking care of my daughter with love - thank you. Perhaps you, more than anyone, have made this thesis possible. To Irene and Terry Lee, for your love and support - thank you.

To Stuart, my husband, who has had the hardest support role, I owe more than can be expressed and I am deeply grateful.

ABSTRACT

A methodology was developed to investigate the question: 'What facilitates pupil learning in classrooms?' The question was interpreted to constrain the methodology in requiring: a naturalistic orientation, a focus on the range of variables influencing pupil experience of content, and a non-selective observation procedure. These constraints led to a study of the experience of three case study pupils during their in-class opportunity to interact with the content of an integrated unit.

A multi-method approach was adopted in order to obtain as much information as possible about pupil experience of content. Three observers alternated in continuously observing and recording the behaviours of the three pupils. Audio-recordings were made of public lessons and audible pupil interactions were noted. Copies of all teacher resources and pupil work were taken. Teacher and observer perceptions were noted.

The pupils were tested before the seven week unit, immediately afterwards, and again one year later. After the long-term posttest, interviews were conducted to obtain: information about the validity of the tests, more information about pupil experience of tested content, and pupil perceptions of their learning.

The test was sub-divided into three parallel sets of items. For each of these items, files were constructed for the case study pupils which included descriptions of their total in-class opportunity to interact with this content. The teacher and researcher engaged in a prediction procedure using pretest responses and records of pupil opportunity to interact with content. This was done to identify extant insight into pupil learning and to reveal researcher bias

which might unduly restrict the data analyses. This procedure showed that both teacher and researcher were able to successfully predict over 70 % of pupil outcomes from the observational record. Factors which inhibited higher prediction success rates for both teacher and researcher were failure to: recognize the primacy of concrete experience as a pre-requisite for long-term learning, identify the presence, persistence, and retro-active effects of pupil misconceptions, account for the strength of the relationship between time and learning, and take into account out-of-class learning opportunities on in-class achievement.

The item files were classified according to the five possible outcomes: already known, learned and remembered, learned and forgotten, not learned, and mislearned. The average time spent by pupils on content which was not learned was less than one fifth of the time spent on content learned and remembered. The number of occasions upon which the opportunity to interact with content occurred was also shown to be related to pupil learning with content learned and remembered occurring over more than six school days.

An analysis of pupil behaviour was carried out in relation to the five learning outcomes. Mean frequencies and rates per hour were calculated in order to show which behaviours were related to learning because they took up the time spent, which behaviours were related to learning over and above the time spent, which behaviours inhibited learning, and which behaviours were unrelated to pupil learning. The consistency of these relationships across the three data sets was also calculated. Opportunity to interact with content both in teacher-directed lessons and in self-directed or peer-directed task contexts was found to be related to learning. Opportunity to attend to a concrete demonstration of new concepts, and opportunity to attend to teacher-pupil discussion were found to be systematically related to pupil long-term learning. Picture attending opportunity and involvement in mime were found to be related to short-term

learning. Rubbing out during individual tasks was found to be consistently related to pupil learning. Peer interaction was found to relate to pupil learning both positively and negatively depending upon task contexts and the rate and type of communication. There were differences between the case study pupils in their overt involvement with content, their perceptions of task requirements, and their ability to obtain useful information from T.

An analysis of exceptions to the overall pattern of findings revealed that chart attending opportunity and diagram drawing behaviour occurred at very high rates for content which was learned in spite of less time spent. Pupil concrete experience and pupil misconceptions were found to be confounding variables in relation to the time spent.

The case study pupils were found to have responded in a characteristic manner to new content with high rates of fiddling, talking to self, and peer interaction. These behaviours are postulated to indicate the occurrence of cognitive conflict and cognitive restructuring in covert pupil processing.

The study findings were used to generate a grounded nascent theory of the learning of the case study pupils. In this theory pupil learning is viewed as the effect of interaction between three major variable clusters: facilitative opportunity to learn, pupil behaviour, and pupil resource access. Given the interaction of the three variable clusters the nature of pupil learning is explained as a three stage process which occurs over time. The first and briefest stage (awareness and disequilibrium) occurs when a pupil actively engages with new content. The more relevant prior knowledge and experience the pupil has, the more likely the engagement in this initial stage of the learning process. The second stage (cognitive restructuring, resolution, and integration) occurs as the child restructures existing schema, and attempts to forge links between existing knowledge and new

content. The final stage (schema development and anchoring) involves the accretion of enough appropriate links to make the new information part of the pupil's general knowledge of the world.

It is claimed that the findings of this study have important implications for research but they are neither generalizable to different contexts, nor prescriptive for practitioners.

INTRODUCTION

> It might be supposed that there was some single method of inquiry applicable to all objects whose essential nature we are endeavouring to ascertain...in that case what we would seek for would be this unique method. But if there is no such single and general method... our task becomes still more difficult. In the case of each different subject we shall have to determine the appropriate process of investigation.
>
> (Aristotle, De Anima 1:1) (McKeon pp. 145-146)

Aristotle's dictum that we should determine the method of inquiry according to the subject of the investigation is a central argument of this thesis on the nature of pupil learning in classrooms.

A past president of the American Educational Research Association, N. L. Gage stated in 1982:

> I could name at least a dozen of our most prestigious AERA members who have written in recent years that educational research, including my own field, educational psychology, has failed to yield significant or useful findings concerning the main effects of educational variables. (p. 11)

I contend that the meagre state of knowledge about pupil learning in classrooms reflects both the widespread use of inappropriate research methodologies and the inadequate formulation of research questions.

Trow's (1957) admission supports this contention:

> Most social scientists, including the present writer, have their favourite methods with which they are familiar and have some skill in using. And I suspect we mostly choose to investigate problems that seem vulnerable to attack through these methods. (p. 35)

Both Cronbach's (1982) call for researchers to abandon methodological orthodoxies, and the current controversy over the use of quantitative versus qualitative methodologies suggest that a tendency for researchers to adhere to methods and even select research questions amenable to those methods is still widespread.

PURPOSE OF THE THESIS

This thesis is an attempt to:

Identify defensible and potentially fruitful questions about pupil learning in classrooms.

Generate a methodology that is appropriate for an investigation of the questions asked.

Justify these claims through the strength and coherency of the findings of an empirical investigation which addresses these questions using the methodology.

Derive an embryonic theory of learning and teaching from the findings.

OVERVIEW OF THE THESIS

In Chapter 1 research which has focused on teaching methods, teacher effects, and pupils is critically reviewed in relation to the research questions asked, the methodologies adopted and the implications for both practice and research.

In Chapter 2 the research questions asked in this study are identified and discussed. The methodology generated to investigate these questions is described and the arguments for methodological appropriateness and defensibility are elucidated.

Chapters 3 to 13, the body of the thesis, contain a record of the empirical investigation of pupil learning.

In Chapter 14 a theory of learning and teaching derived from, and grounded in the findings is advanced. Finally, in Chapter 15, the implications for future research on pupil learning in classrooms are drawn.

CHAPTER 1

REVIEW OF RESEARCH

We must, with a view to the science which we are seeking, first recount the subjects that should first be discussed. These include both the other opinions that some have held on the first principles, and any point besides these that happens to have been overlooked.

(Aristotle, Metaphysics 3:1) (McKeon p. 715)

That education should be regulated by law and should be an affair of state is not to be denied, but what should be the character of this public education, and how young persons should be educated, are questions which remain to be considered.

(Aristotle, Politics 8:2) (McKeon pp. 1305 - 1306)

1.1 OVERVIEW

Aristotle's views on education have strongly influenced the character and curricula of public education over almost 2000 years. However, Aristotle did not regard education as the subject of empirical investigation. The view that the determination of the precepts of education is a matter for logical analysis has been longstanding. Aristotle's philosophy along with views of education advanced by philosophers such as Plato, Comenius, Locke, Rousseau, and Dewey have formed the foundation stones of debate in education to the present day. In comparison systematic empirical investigation into educational issues only began towards the end of the 19th century. The process of examining the assumptions which constitute the basis of educational 'wisdom' has been slow and difficult. As a base of empirical findings has developed, however, it has become apparent that traditional logic does not adequately explain the processes of learning and teaching. Anderson (1950) pointed out:

> Our organization of learning content and activities has, historically, been Aristotelian. The organization has been an organization of logic... But psychological research has demonstrated that learning experiences are not necessarily logical. (p. 10)

When researchers have succeeded in revealing fallacies in the conventional wisdom, their efforts to provide empirically-based, holistic theories with direct relevance for practitioners have been limited. A steady stream of reviews and commentaries, since the early 1950s, has emanated from researchers and educators alike bewailing the inadequacy of educational research to illuminate

learning and teaching in classrooms (Glass, 1972; Good, 1980; Harnischfeger and Wiley, 1978; Kallos and Lundgren, 1975; Kerlinger, 1977; Phillips, 1980). Jackson's (1978) comment is extreme but not atypical of this widespread disaffection for the 'state of the art':

> Indeed, our chief advance seems to be that of moving the null hypothesis a shade closer to being hailed as the one and only educational law! (p. 397)

Counter arguments have been advanced. Rosenshine (1983) and Good (1978) have argued that there is sufficient empirical evidence available now to specify the major characteristics of effective teaching. However, the lack of widespread acceptance of this view, the relatively small number of empirical studies on which they base their conclusions, and the absence of explanatory theory associated with these conclusions indicate that the promise of scientific illumination of classroom learning and teaching has not yet been realized.

There are two possible conclusions about the general state of educational research. Either the practice of education is not amenable to empirical investigation or researchers have not yet developed methodologies which are appropriate to investigate, and to provide answers to, the kinds of questions which are central to educational practice. It would be premature to accept the first conclusion before adequately addressing the second.

Given that systematic empirical investigation in education has been carried out for barely one century, and the fact that empirical investigation on the natural sciences has been carried out for several centuries, the failure of research to make dramatic breakthroughs in our understanding of classroom practice can be seen as a

developmental problem. In order for significant progress to occur an exploratory orientation is necessary to identify, at least, more useful research questions. Unfortunately, however, the exploratory orientation warranted by the relative infancy of our research has been ignored or too quickly bypassed in the desire to achieve prescriptions for effective teaching.

Further, the research tradition in education has been singularly remiss in its failure to critically self-evaluate by validating or repudiating those underlying assumptions which are the heritage of 2000 years of logic and opinion. Rather, researchers have taken many of those assumptions as given and few investigations have involved analyses of underlying assumptions and commitments which infuse the research questions asked, the data selected, and the methodologies employed.

A brief overview of the kinds of traditions which have impinged upon our understanding of pupil learning in classrooms is provided in section 1.2. Three areas of research focus are considered in more depth in sections 1.3, 1.4, and 1.5. A summary of the review and implications for the present study are briefly outlined in section 1.6.

1.2 RELEVANT TRADITIONS

A number of different research traditions have impinged upon our understanding of pupil learning in classrooms. Since the early work of Thorndike (1906) psychological learning theories based on various 'laws of learning' have been advanced as explanations for practitioners. Thorndike's focus on learning in classrooms, however, has been atypical of the focus of learning theorists over the

past century.

The work of Hull (1931), Tolman (1931), Lewin (1951) and Mowrer (1960) resulted in theories of learning that did not readily translate into classroom settings. For example, issues such as reinforcement, extinction, retroactive inhibition, and transfer were not widely investigated in relation to children's learning in classroom conditions. Accordingly, the early behavioural theories of learning came under strong attack from educators such as Jackson (1968) who argued that behaviourists were 'private tutors par excellence' whose success, like that of the teacher with a whole class of pupils, would be more limited when faced with flocks of pigeons or packs of rats. The pragmatic value of early learning theories was empirically investigated by Aspy (1972) who found 'little statistical correlation between teachers' knowledge of learning theory and their classroom behaviour' (p. 24).

A strong tradition of the study of teaching methods using experimental research methodologies has been alive and well throughout the past century in spite of the recurrent criticism that the results of these studies 'have tended ... either to be inconclusive or to contradict the results of other methods experiments' (Medley, 1979, p. 14).

Both the teacher effectiveness, and classroom interaction research traditions have focused primarily on teachers, and latterly, on teaching in classrooms. However, many of the most critical comments (cited earlier) on the dearth of useful findings for understanding practice have been directed at these two traditions.

A tradition with more modest aims has been that of curriculum evaluation research. In order to generate information of immediate value to educators, evaluative

researchers have focused on specific programmes in specific contexts. This approach is in direct contrast to the widespread concern in experimental studies of methods, and studies of teacher behaviours, to 'control' for context variables. The failure of those traditions to control for context and generate worthwhile findings led Glass (1972) to argue that curriculum evaluation research is the only defensible type of inquiry into classroom learning. Glass argued that researchers would do far better to investigate the practice of inspired teachers than to continue to waste money by seeking causal explanations through elucidatory research.

Studies of pupil variables have been varied and only latterly focused on children in classroom settings. Yet these kinds of studies have had perhaps the most powerful impact on educational practice; for example, the intelligence testing tradition and the work of Piaget.

Recently the large scale studies of schools (Coleman, Campbell, Hobson, McPartland, Mood, Weinfield, and York, 1966; Jencks, Smith, Acland, Bane, Cohen, Gintis, Heyns, Michelson, 1972; Peaker, 1971; The Plowden Report, 1957; Rutter, Maughan, Mortimore, Ouston, and Smith, 1979) have called into question the extent to which schools affect the variability in pupil achievement independent of pupil background variables. Research investigations of the 'hidden curriculum' in educational institutions (Apple, 1981; Bowles and Gintis, 1976; Willis, 1977) have served to initiate questions about the traditional assumptions of educational practice and theory that have long been unchallenged. Research, such as that carried out by Bowles and Gintis (1976) has suggested that many of our longstanding assumptions about educational practice may be myths useful for perpetuating the power structures of capitalist societies.

The development of a new focus in the study of pupil behaviours and perceptions in relation to classroom tasks has been outlined by Doyle (1984). It has been influenced by recent work in cognitive psychology and cognitive anthropology. In this approach pupil experience of tasks is taken as a beginning point in understanding the relationships between pupil behaviours and perceptions, content, context and learning.

The growing focus of all these traditions on pupil learning in classrooms has contributed to a merging of research traditions. While Glass (1974) was issuing a call for a shift from elucidatory inquiry to curriculum evaluation, curriculum evaluators such as Leinhardt (1978) were arguing the benefits of applying a classroom process model to curriculum evaluation. Researchers in the teacher effectiveness tradition such as Berliner and Rosenshine (1977) and Brophy and Good (1983) have argued the need to focus on pupil variables and have outlined prescriptions for effective teaching methods.

Although all the traditions discussed above have influenced the course of this study in some way, the following review is limited to three key areas of research focus: the teaching method, the teacher, and the pupils. The review includes (a) an historical account of the kinds of investigations which have been addressed to each of these key areas, and (b) a discussion of the kinds of problems which have beset those investigations and the insights revealed for research into pupil learning in classrooms.

1.3 RESEARCH INTO TEACHING METHODS

1.3.1 Historical Overview of Research into Teaching Methods

Systematic investigation of teaching methods has been a major focus of educational research throughout the past century.

In the early 20th century enthusiasm for the potential of experimental comparisons of teaching methods to illuminate practice was considerable. The publication of a new journal, The Journal of Experimental Pedagogy, to report this wisdom was seen to herald a golden age in educational practice (Spearman (1911-1912).

The progress in advancing knowledge in the natural sciences was apparent and the experimental methodology seen to be so instrumental in that advancement was adopted wholeheartedly by educationists. Medical and agricultural models of experimental research were considered appropriate to investigate the complexities of classroom processes. Teaching methods were viewed as treatments. Treatment A (Method A) was compared with Treatment B (Method B) to establish the superiority of one of those Treatments (Methods). The concern that research be relevant to practice was considerable and a number of articles were published (Brown, 1911-1912; Bompas-Smith, 1911-1912), which argued that researchers, ideally, should be skilled not only in research but also as practising classroom teachers. Experimental investigations of both particular methods of teaching specific subjects and content, and general teaching methods or styles were carried out. A lively controversy on the relative

merits of different methods of teaching reading, for example, was reported in the earliest editions of The Journal of Experimental Pedagogy (Gill, 1911-1912; Valentine, 1913-1914).

The perennial debate of expository teaching versus discovery learning took root when Winch (1913) published an account of his investigations into methods of teaching mathematics in a book entitled Inductive versus Deductive Method of Teaching: An Experimental Research. The results of three out of five of Winch's experiments suggested that the deductive method was significantly superior for immediate and delayed retention tests. In one experiment the inductive method was associated with significantly higher retention and in two experiments the inductive method was significantly associated with superior mean transfer scores. Winch summarized his results as showing the superiority of inductive methods because of the desirability of transfer effects in learning.

By the early 1930s an entire issue of the Review of Educational Research (1931) could be devoted to research on teaching methods, and specific issues central to mathematics and reading instruction were enlightened by a considerable body of empirical evidence. It became evident, however, that the empirical findings would not easily supplant the accepted educational wisdom. For example, the longstanding controversy about the relative merits of the phonic and the 'sentence meaning' approaches to teaching reading seemingly had been resolved by studies showing the superiority of the sentence meaning approach for beginning readers (Gray, 1931). However, commitment to the phonic approach to early reading has persisted in educational practice.

The debate about the expository approach versus the discovery learning approach reappeared in slightly different form in a review by Broenig (1939), who provided support for the progressivists when she concluded that the research showed activity and project methods to be superior to traditional 'teacher-centred' methods. Broenig predicted that there would be a trend away from studies of general methods but this prediction was shown to be inaccurate as the study of general methods persisted into the 1950s and 1960s. By this time the views of practitioners were less enthusiastic than those expressed in the initial editions of the Journal of Experimental Pedagogy. Comments by Lorge (1954) showed the growing disaffection of practitioners with the research findings:

> During the last thirty years, a considerable amount of effort has been expended in attempts to evaluate the various methods of teaching in order to find a 'best', or at least a better method... The experimental literature allows every teacher to find support for any method... (p. 168)

Anderson (1959) reviewed 32 studies comparing learner-centred versus teacher-centred methods and found 11 which showed greater learning occurred when learner-centred methods were used, eight studies which showed greater learning from teacher-centred methods and thirteen studies which showed negligible differences in learning outcomes.

This pattern of results was continued in Dubin and Traveggia's (1968) review of the effectiveness of lecture versus discussion methods at college level. Their analysis of the results of 88 comparisons between the two methods reported in 36 experimental studies showed 51% favoured the lecture method and 49% favoured the discussion method.

Hermann (1969) reviewed the experimental studies of discovery learning, including Winch's early work. Hermann's conclusions were very similar to those made by Winch. His analysis showed better retention associated with the non-discovery methods and better transfer from the discovery method. Although most of the studies showed no significant difference between the methods, the ratio of 12:5 significant results in favour of the discovery method led Hermann to conclude that the research favoured discovery methods.

Jamison, Suppes and Wells (1974) reviewed studies which had compared the use of instructional radio, and programmed learning with traditional teaching methods. Their review showed no substantial differences between the traditional and alternative methods.

Bennett's et al. (1978) extensive study of 'teaching style', a large-scale comparison of 'progressive' versus traditional teaching styles, led the authors to champion traditional methods through an instructional film which vividly illuminated their results. Nevertheless, only two percent of the variance in pupils' scores was independently attributable to teaching style in this study, and the single most outstanding effect on children's achievement was brought about by a teacher who used a progressivist approach.

The inconclusiveness of the results of teaching methods research did not go unnoticed. White's (1976) experimental research on discovery learning overcame many of these problems and significant results were obtained for the measured variables. He operationally defined discovery learning as the amount of guidance the learners were given, investigated the effects of prior knowledge, guidance given to learn each element in a learning hierarchy, and sequencing effects. White found that random sequencing of the elements did not affect pupil learning, how they had learnt previous elements did not affect later learning , and the greater the amount of guidance given the quicker the students learned.

These unequivocal results, however, as White (1984) himself pointed out, were obtained at the expense of classroom validity and the conclusions would not have much to offer teachers. White (1984) critiqued his own work:

> I chose this study to illustrate the research of a decade ago because it is a fine example of its type: rational, complex, ingenious, even elegant; but containing no surprise in the result, not interesting to teachers, and having no impact on practice. The point to notice is that the learners were of no individual importance: their actions, responses, which I planned to observe were limited beforehand to the number of tries they took to reach criterion. Their thoughts were ignored. Any variation between them in a cell was of no interest except as an

> estimate of what, significantly, is often termed 'error'. Yet, looking back, I see that ignored variation was the most fascinating and important part of the investigation. (p. 6)

White's reaction to his awareness that this kind of methods research is not illuminating for practitioners and researchers alike, was to investigate naturally occurring method through the experience of the pupil (McKenzie and White, 1982).

White's change of direction was symptomatic of a broader change which has taken place in investigations of teaching method emanating from the study of naturally occurring methods common to the practice of effective teachers. A number of researchers have now turned away from experimental studies of teaching methods towards naturalistic investigations of extant methods.

At the same time , a number of other researchers have attempted to summarize the results of classroom-based process-product studies and the evaluations of large scale intervention programmes (for example, Follow Through) by describing the single most effective method of teaching. Inspired largely by the reviews of Rosenshine (1968), (1971), (1976), (1979), and the success of the Direct Instruction Follow Through Programme (Becker, 1977) they characterized this method as 'direct instruction' or 'active teaching'. Berliner and Rosenshine (1977) described the method:

> Direct instruction means a set of teaching behaviours that focus on academic matters in which goals

> are clear to students, time allocated for instruction is sufficient and continuous, content coverage is extensive, student performance is monitored, questions are at a low cognitive level producing many correct responses, and feedback to students is immediate and academically oriented. The teacher controls instructional goals, choosing material appropriate for the student's ability level, and pacing the instructional episode. Interaction is characterized as structured but not authoritarian. (p. 382)

Brophy and Good (1983) summarized the effective teaching method in teaching basic skills in the primary grades, in their characterization of 'active teaching':

> These classes include frequent lessons (whole class or small group, depending on grade level and subject matter) in which the teacher presents information and develops concepts through lecture and demonstration, elaborates this information in the feedback given following responses to recitation or discussion questions, prepares the students for follow up seatwork activities by giving instructions and going through practice examples, monitors progress on assignments after releasing the students to work independently, and follows up with appropriate feedback and reteaching when necessary. (p. 103)

For some years there has been concern for the possible interaction that might occur between teaching methods and pupil aptitudes (Snow, 1977). It has been argued that the failure of research to identify effective methods has been because teaching methods interact with pupil characteristics to produce different outcomes for different types of students. An example of this type of research is a study by Anderson and Scott (1978) entitled: 'The relationship among teaching methods, student characteristics, and student involvement in learning'. Anderson and Scott concluded their discussion of this study by stating:

> ...different students tend to benefit differently from different teaching methods. (p. 57)

They found that students with low aptitude and low self-concepts benefited more from classroom discourse and seatwork rather than lecture methods and group work. Students with high aptitude and high self-concepts benefited more from audio-visual approaches than students with low aptitude and self-concepts. The outcome measures in this study were student behaviours rather than learning outcomes and benefit was inferred from on-task behaviour. The difficulty of the inferences involved when using 'on-task' behaviour as an outcome measure are discussed later in this chapter.

Cronbach and Snow (1977) found an alternative solution for the discovery learning versus the expository approach controversy in their finding that high ability students achieved more given more 'freedom to proceed in their own manner' (p. 503) and that low ability students achieved more given more guidance and structure.

However, although the results of individual studies such as Anderson and Scott's suggest the value of looking at pupil variables in relation to specific teaching methods, the overall results of aptitude-treatment interaction studies have not fulfilled the promise they were believed to have. Because of the difficulty in obtaining replications of aptitude x treatment interaction effects, commentators such as Cronbach (1975) suggested that this approach should be abandoned. All of the problems associated with traditional 'methods' research are inherent in the aptitude-treatment interaction studies. Classifying pupils by ability or personality measures narrows the range of error in the generalizability of the results but still treats methods and pupils as classifiable objects in a traditional research design.

1.3.2 Problems in the Research on Teaching Methods

In order to follow Aristotle's advice to consider the points which may have been overlooked in preceding research, problems endemic to studies of teaching methods are discussed in the following section.

Four problems in particular have contributed to the failure of research into teaching methods to illuminate practice. The research questions, the characterization of method, philosophical and methodological commitments, and the failure to heed the finding of 'equipotentiality' of methods, will each be considered.

1.3.2.1 The Research Questions

Much of the research into teaching methods has involved the use of experiments. And the experimental paradigm, as Cronbach (1957) pointed out, not only provided a way to answer research questions, but also governed the way those questions have been asked. The question, 'Is Method A more effective than Method B?' historically preceded the question, 'What is Method A and what elements of Method A facilitate learning?' because researchers assumed that methods were single, independent treatments amenable to experimental comparison.

1.3.2.2 What is 'Method'?

Disagreement amongst educationalists about the definition of 'teaching method' was prevalent at the turn of the century. Findlay (1911-1912) claimed:

> To define the scope of Method. I do not think there is much dispute in the use of this term by teachers... Method includes <u>all that the teacher has to consider in preparing his lessons</u> [emphasis added] when 'a piece of teaching' ... has been allotted to him. (p. 233)

Findlay went on to distinguish 'modes of learning' such as inductive learning from 'devices of teaching' such as the blackboard; both of which were subsumed by the term, 'Method'. His query as to whether educationalists could agree upon the various 'modes of learning' was responded to by

Raymont (1913-1914) who argued that the term 'method' only defines the way in which the teacher orders the content to be taught. Even if Raymont's view of method were disregarded as an atypical conception of method, Findlay's definition is so broad that it suggests that method could be unique for every teacher, content and context combination. Nuthall (1974) argued against an assumption of generality in methods and cited observational evidence from Gallagher (1970) that even when teachers were trained to use the same 'method' they modified the procedures considerably. Anderson and Scott (1978) pointed out that in practice, elementary teachers use several teaching methods within a single period.

On the basis of the findings from descriptive research Berliner and Rosenshine (1977) defined method as a complex of three key variables:

> These methods are recurrent instructional activities, applicable to various subject matters, and include: (1) patterned teacher behaviour (e.g., lecturing, discussion recitation), (2) delivery systems for curriculum (e.g., film, computer assisted instruction, written discourse), and (3) organizational structures for promoting learning (e.g., cross-age tutoring, independent study, Keller plan). (p. 378)

However, this comprehensive definition of the components of method simply gives more structure to the definition advanced in 1911 by Professor Findlay. It does not illuminate further those elements of method which are critical to children's learning.

1.3.2.3 Philosophical Commitment

A third problem underlying the research on teaching methods has been that of philosophical investments associated with teaching methods.

The 'Socratic method' was not just a way of teaching but a procedure based upon a belief about the inductive nature of learning. Philosophical commitments which have influenced method have been derived both from beliefs about the nature of learning and views about the nature of the content to be taught. For example: Cotten, Evans and Tseng (1978) assumed 'science teaching in the primary school must exemplify the nature and structure of science to be effective in our rapidly changing society' (p. 187). Recent research suggests that conceptions of teaching method based on philosphical positions may have obscured our vision of the complex ways in which combinations of teaching methods effectively facilitate pupil learning. Biddulph and Osborne (1984) rejected the traditional contrast between the 'knowledge-transmission' method and the 'activity-discovery' method. In the light of their investigations of pupil learning in science they argue that this contrast has not been a fruitful way to conceptualize effective teaching and they outline as more effective an <u>interactive</u> teaching method involving elements of both

approaches.

Even when there has been consistent evidence for the superiority of a particular method, which has admittedly been rare, practitioners have been reluctant to accept the evidence. For example, as discussed earlier there has been continuing advocacy for the phonic approach to reading persisting into current literature in spite of consistent evidence for the superiority of sentence meaning approaches to early reading.

Philosophical commitments based upon logical beliefs which 'explain' the methods championed have proved enduringly attractive to practitioners not only when there has been a demonstrable explanatory vacuum but also when there has been contrary evidence.

1.3.2.4 The Importance of Teaching Method

Perhaps the overwhelming finding of the whole research tradition into teaching methods is that the kind of method employed to bring about pupil learning is not a key issue.

Every reviewer of experimental studies of teaching methods cited in this review has reported studies which support particular methods, along with studies which provide support for alternative methods. In spite of the definitional problems which have undermined much of this research there have been carefully operationalized investigations dating from Winch's work at the beginning of the century. The fact that there have been individual studies which have found significant differences between different methods but that the direction of those differences

has not been consistent in other studies of the 'same method', suggests that these kinds of studies functioned as curriculum evaluation research. The results provided valuable but context-bound information for the educators involved, about the superiority of one method over another.

There is another important implication of this research. If alternative methods do not, overall, make dramatic differences in pupil achievement, then the method differences may not be as important in influencing pupil learning as other variables.

Nuthall (1974) argued that what teachers think of as methods may be a small and possibly insignificant part of what teachers do to promote pupil learning.

Berliner and Rosenshine (1977) suggested that the equipotentiality finding may point to overwhelming similarities in pupils' cognitive processing of new content which minimize method effects:

> The fact that socially significant amounts of knowledge are acquired regardless of the curriculum or teaching method chosen for instruction has important implications. It means that at some level yet to be understood, the information value of the material presented in the various curricula and methods is often equivalent, at least when the class is the unit of analysis. Perhaps information that is conveyed by the various curricula and teaching methods is coded, stored, and retrieved from

> memory in similar ways by different people, no matter how the information was first obtained. (p. 380)

The implications of the 'equipotentiality' of general teaching methods, demonstrated in this review, can no longer be dismissed in general criticism of the quality of the research which has been conducted in this field. The search for a magic method which can be demonstrated to be generally more facilitative of pupil learning than alternative methods irrespective of context has not been fruitful. The evidence from this review suggests that it may be more fruitful to identify those elements of naturally occurring methods which are particularly facilitative of pupil learning. The results of a century of investigation suggests that the time has come to investigate and identify context variables which confound this research. Attempts to control for context variables have been shown empirically to be at least premature - in classroom settings. By investigating not only which elements of method and context facilitate pupil learning but also how and why those elements facilitate pupil learning we may gain insight into the equipotentiality finding. White's (1984) argument that the focus of interest should be the pupil's experience of method points to a potentially fruitful approach to addressing those how and why questions.

1.4 TEACHER EFFECTIVENESS RESEARCH

1.4.1 Historical Overview of Research on Teachers

Research on teacher characteristics has been carried out in some form over the past century.

The early research involved collating pupil and/or expert views of the qualities of effective teachers. In a review of the Early History of Research on Teacher Behaviour Medley (1972) traced the literature back to a study by Kratz (1896) who investigated pupil views of the characteristics of the 'best' teachers. Medley identified Hart's (1936) survey of 10,000 high school students as one of the largest of this kind of investigation. The characteristics of good teachers most frequently cited by these students were: teaching skill (clarity, use of examples, good organization) cheerfulness, friendliness, interest in pupils, impartiality, and fairness.

It was not until the late 1930s, however, that attempts were made to investigate the relationships between teacher behaviours and student outcome measures. Lewin, Lippit and White (1939) postulated that democratic or 'indirect' teachers would be more effective than autocratic or 'direct' teachers. Flanders (1963) was convinced that 'indirectness' was a quality of effective teachers which created the optimal classroom climate to facilitate pupil learning. He developed the most widely used observational category system in classroom research, the Flanders Interaction Analysis Categories (FIAC), to enable teachers to be classified according to the indirect:direct ratio in their teaching behaviours. Flanders' commitment to the

importance of indirect behaviours led to a plethora of presage-process research involving training systems to increase indirect behaviours in student teachers. Flanders (1969) summarized a review of these presage-process studies (Allen et al., 1966; Bowers and Soar, 1961; Flanders et al., 1963; Hough and Amidon, 1954) with the conclusion that 'the correlations are still too low to give promise of utility' (p. 32).

Dunkin and Biddle (1974) reviewed 36 studies of the relationship between teacher directness or indirectness and pupil achievement. Of these studies 20 found teacher indirectness to be unrelated to pupil achievement, 10 found teacher indirectness to be positively related to pupil achievement and six found conditional relationships between teacher indirectness and pupil achievement. Dunkin and Biddle concluded: 'Among field survey findings we discover that teacher indirectness is (and is not) associated with greater pupil achievement' (p. 118). This kind of summary statement is archetypal in reviews of teacher effectiveness studies.

Flanders' observational system did serve to focus researcher attention upon teacher questioning behaviour which has been believed to be critical to pupil learning since Plato described the centrality of questioning in the teaching of Socrates. The work of Bloom, Egelhart, Furst, Hill and Krathwohl (1956) in the construction of the Taxonomy of Educational Objectives, and the views of Taba (Taba, 1963; Taba, 1966; Taba, Levine and Elzey, 1964) contributed a strong commitment to the principle that teachers should strive to raise the level of cognitive thought in classrooms through high-level questioning.

However, the empirical evidence regarding the relationship between high-level teacher questions and pupil achievement yielded contrary results. Wright and Nuthall (1970) found closed questions to be positively correlated with pupil achievement. Stallings and Kaskowitz (1974) found low-level factual questions to be positively correlated with pupil learning in 166 first and third grade classrooms. And Medley (1979) concluded that the research shows effective teachers ask more low-level questions and fewer high-level questions.

A legacy of both the behaviourist influence and the classroom climate tradition was the assumption that children's achievement would be positively related to teacher praising behaviour. Again, however, the findings of empirical studies have not clearly supported this assumption. Although Wright and Nuthall (1970) found a positive correlation between teacher use of thanks and praise in seventeen standard two classes, Brophy and Evertson (1974) found teacher praise to be related to pupil achievement in complex ways. Praise correlated negatively with achievement in high SES classes and positively in low SES classes; however, the correlations were weak. Gage and Berliner (1975) reviewed 14 studies which had investigated the effects of teacher praise on pupil achievement, and found eight findings of positive relationships between teacher praise and pupil achievement and six findings of negative correlations between teacher praise and pupil achievement.

Unequivocal relationships between teacher behaviours and pupil learning seem elusive. Church (1976) identified factors which may have contributed to the inconclusive findings and developed an experimental design to investigate pupil learning of a topic in science (electricity) taught over three lessons. He

found that children's prior knowledge was the best single predictor of achievement, content covered was the next most highly correlated variable, and the number of teacher questions, as well as the number of low-level teacher questions, were also correlated with pupil achievement. In order to identify the variables critical to pupil learning, Church excluded from the analysis children with very high or very low levels of relevant prior knowledge. Thus he was able to obtain significant relationships between teacher behaviours and pupil learning after controlling for the extremes of pupil entering characteristics.

Church's results do support other studies of teacher effects (for example: Brophy and Good, 1974; Stallings and Kaskowitz, 1974). In recent research there has been some consistency in the results for a variety of teacher behaviours: teacher structuring of content, repetition of key concepts, clarity, enthusiasm, use of low-level rather than high-level questions, pacing and use of wait-time before soliciting student responses, and performance in responding to pupil responses (Brophy and Good, 1983). But as these authors pointed out, 'even the most generally replicated findings (on teacher effects) tend to be based on low to moderate correlations' (p. 100).

The last decade has seen a change of emphasis in teacher effectiveness research towards investigations of teacher provisions for pupil practice and content covered. These variables have been found to be far more strongly related to learning than teacher behaviours. Stallings and Kaskowitz (1974) found 'time spent' by pupils or 'opportunity to learn content' to be more clearly and strongly related to pupil achievement than any other variable. Armento (1975) and Rosenshine (1968) found correlations between content covered and pupil achievement to be larger than

those obtained for any teacher behaviour variables. Anderson (1976), Bloom (1974), Good and Beckerman (1978), Hops and Cobb, (1974) and Wyne and Stuck (1979) found a strong positive relationship between the time students spent engaged in learning and their subsequent educational performance. Reviews by Caldwell et al. (1982), Karweit (1982) and Stallings (1981) reflect the continuing fruitfulness of investigations of the 'time spent' variable to pupil achievement. Both 'time spent' variables and 'content covered' variables have been shown to be critical to pupil learning. These kinds of findings provide an insight into possible reasons for the unclear results in the methods research tradition, and the research on teacher behaviours. They also point to the need to focus on pupil behaviours in classrooms in order to facilitate understanding of the effects of teacher behaviours.

1.4.2 Problems in Teacher Effectiveness Research

Problems in the research questions asked and the strength of philosophical commitments have contributed to weaknesses in this tradition as they have for the teaching methods research. Research on teaching has also been vexed by unwarranted assumptions about the stability of teacher effectiveness, and the stability of relationships between teacher behaviours and pupil outcomes. The fourth problem considered in relation to this research is the fundamental issue of the appropriateness of teacher behaviours as units of analysis in research on pupil learning.

1.4.2.1 Research Questions and Prevalence of Correlational Studies

The teacher effectiveness research questions have been formulated upon the assumption that there are direct relationships between teacher behaviours and pupil achievement. The standard question in this field has been: 'Is teacher behaviour, A, related to pupil achievement as measured on test B?' The selection of A has been strongly influenced by commitments to principles such as the desirability of high-level cognitive processing to which the behaviour in question is assumed to relate. The widespread use of correlational or experimental designs that 'control' for other variables has led to the framing of questions around isolated teacher behaviours. Nuthall (1974) argued of this tradition:

> By taking for granted that the criteria for good scientific procedure and data analysis are well-established and beyond dispute, we have been led into asking the wrong kinds of questions and searching for the wrong kinds of answers. (p. 3)

Although the research on teacher behaviours began with an exploration of a wide range of teacher and pupil behaviours (evident in Mirrors for Behaviour, II, Simon and Boyer, 1971) the constraints of traditional research designs, commitments to certain philosophical views, and the desire to produce immediate practical prescriptions for teachers, have led researchers into examining and re-examining a

narrowing range of teacher behaviours. For example; praising, criticizing, asking high- or low-level questions, and accepting pupil responses. Thus the methodological tradition has not only determined the kind of question asked; it has led to a focus on the same kinds of teacher behaviours in the same kinds of teacher-directed lessons.

Borich (1979) argued that the large studies of the past decade (Brophy and Evertson, 1974; Good and Grouws, 1975; McDonald, Elias, Stone, Wheeler, Lambert, Calfee, Sandoval, Ekstrom and Lockheed, 1975; Soar, 1966; Soar and Soar, 1972; Stallings and Kaskowitz, 1974) have served as a comprehensive exploratory stage in classroom research. Borich suggested that these kinds of results may represent the kind of potential for hypothesis-generation that can be achieved using correlational designs. He argued further that in the relative absence of experimental studies the hypotheses generated by these correlational studies have been inappropriately conclusion-oriented and have resulted in an atheoretical approach in the field. Thus, even Borich, who has a relatively optimistic view of the contribution made to practice by the process-product tradition, has called for alternative approaches to understanding pupil learning in classrooms.

There has been a continuing unease in this tradition about the kinds of methodologies employed and the failure of the research questions to lead to understanding of causal variables in relation to pupil learning.

1.4.2.2 Appropriateness of the Unit of Analysis: Teacher Behaviours

The ways in which context, content, quality, and appropriateness influence the impact of any teacher behaviour on pupil achievement have not consistently been taken into account in the teacher effectiveness research. The arguments for identifying rather than assuming the unit of analysis in teacher effectiveness research are discussed in Chapter 2.

However, there is a problem inherent in attempts to correlate teacher behaviours directly with pupil outcomes which has not been adequately addressed in the research. The links between teacher behaviours and pupil outcomes are mediated by pupils who may perceive teacher behaviours in quite different ways from those that researchers assume. Anderson (1981) found that students perceive teacher-set tasks in ways which are very different from the ways teachers intend those tasks to be perceived.

Pupil attending behaviour is a critical mediating variable for the teacher behaviours investigated. The almost universal assumption in this research tradition, that pupil attending behaviour can be inferred on the basis of common sense notions, is simply not borne out by research findings. Berliner and Rosenshine (1978) claimed:

> The variable called active learning time (synonyms are engagement, attention, and on-task behaviour) is easily coded. Every time a student is apparently on-task during a teacher's allocated time for a lesson, a

> stop watch can be run. When the student is apparently off-task (looking out the window, going to the restroom, doodling, talking, etc.), the observer can stop accumulating time. [emphasis added] (p. 384)

However, there is now a considerable body of evidence which suggests that observer judgements of pupil attending behaviours lack validity. Brophy and Evertson (1974) devoted two pages of discussion to what they considered to be a critical anomaly of their study, that pupil attending behaviour as rated by trained observers did not relate to pupil achievement. The majority of these ratings showed very low and statistically non-significant correlations with pupil achievement. Taylor (1968) compared three methods of assessing student attention and concluded that observer ratings provide invalid measures of student attention. Peterson and Swing (1984) found that pupil reports of their own mental processes during teacher-directed lessons provided considerably more insight into their learning than observer judgements of attending behaviours.

Winne and Marx (1980) have argued that the assumption of simple relationships between teacher behaviours and pupil learning has been a major weakness of the process-product paradigm:

> ...teachers do not influence directly student product variables, such as achievement. Rather teacher process variables influence students by causing them to think or behave differently... Hence, the more proximal effects of teaching on learning are

> mediated by state-like changes in students during the course of instructiion. (p. 1)

Marx and Winne advanced an alternative 'cognitive mediational paradigm'.

Widespread assumptions about a simplistic relationship between teacher behaviours and pupil mental processing have inhibited valid investigations of actual relationships between these variables. It is necessary to understand these relationships before we can make inferences about the role of teacher behaviours in facilitating learning.

1.4.2.3 Assumptions of Stability

Research on teacher effects has been riddled with unvalidated assumptions about the stability of teacher effectiveness and the stability of relationships between teacher behaviours and pupil outcomes.

The assumption that teacher behaviours are stable variables which can be sampled and will persist over time in the teaching practice of a given teacher irrespective of teaching context has been unsupported by empirical findings.

Rosenshine (1969) drew attention to the first issue:

> The results...do not provide support for the idea that a 'good' teacher is consistent in the effects he obtains as

> measured by adjusted pupil achievement scores. (p. 16)

It seems that teachers like methods are generally not consistent in their effects. Rather, teachers are effective in some instances and ineffective in others. One explanation for this variation is apparent in Brophy and Evertson's (1974) finding that certain teacher behaviours such as criticizing had quite different effects on pupils from different SES backgrounds.

Winne and Marx's arguments discussed in the previous section support the view there are other important explanations for instability in the relationship between teacher behaviours and pupil achievement. This issue is considered further in Chapter 2.

In a sense the conflicting results of the research on teacher effectiveness provide the evidence that assumptions of stability have been unwarranted . It seems the time has come to identify the kinds of variables which bring about such instability rather than to persist in the perennial search for relationships between teacher behaviours and pupil outcomes that are universally consistent.

1.4.2.4 Philosophical Commitments

The persistence of simplistic studies of teacher behaviours can be partially attributed to the longstanding philosophical tradition of conceptually analyzing education in terms of the teacher's intentions and behaviours. Relatively recent examples of this tradition can be found in the work

of Deardon (1967), Gribble (1969), Peters (1965), and Scheffler (1960).

The commitment to the the teacher as an independent variable in bringing about pupil learning has overshadowed the substantial findings of empirical research in other fields which clearly point to interaction effects between teacher behaviours and other variables. Parents, peers, and the pupils themselves have been shown to affect in-school achievement. (Beckerman and Good, 1981; Biddulph, 1983; Coleman et al., 1966; Jencks, et al., 1972; Peaker, 1971; Watson et al., 1981; and Webb, 1981).

Further, there has been a prevalent (but understandable) bias towards identifying the positive effects that teachers have on children. It is apparent that teachers do have effects on children, and also apparent that these effects are not always facilitative of pupil achievement, pupil self-esteem, or pupil well-being.

The failure to evaluate commitments in the field of teacher effectiveness research has inhibited the growth of understanding about how teachers do influence children.

1.5 RESEARCH INTO PUPIL CHARACTERISTICS AND BEHAVIOURS

Research into pupil characteristics has been prevalent since the late 19th century; however, research into pupil behaviours in classrooms has been relatively recent even compared with the research into teacher behaviours in classrooms. Because the research on pupil characteristics has emanated from a number of distinct research traditions

with a wide variety of research questions and methodologies, the problems associated with this research are discussed in the course of the following review rather than at the end.

1.5.1 Overview of the Research into Pupil Characteristics

In 1870 a study of the 'contents of children's minds' based upon class or small group interview responses of over 2000 children who had just entered school was reported in the Berlin Stadtiches Jahrbuch (cited in Hall, 1893). The basis of this investigation was the hypothesis that children with different experiences (notably country children and town children) would have different sets of concepts. It was argued that a description of the differences in the kinds of concepts familiar to children with different experiences should regulate school-walks and excursions, object-lesson material, and the subject matter of reading, writing and other school subjects.

The results showed strong differences between the vocabulary and experiences of the country children and the city children. For example only 48% of the city children had been on a hill or mountain before entering school whereas 74% of the country children had had this experience. The study was descriptive and percentage frequencies were used to investigate the hypothesis.

The assumption that children's prior-to-school experiences of the world do affect their school achievement is a proposition about an interaction between home factors and school achievement factors that has not been adequately investigated in the century of educational research following this study.

A substantial explanation for the failure to investigate the effect of children's preschool experiences on their in-class achievement can be found in the impact of the tests of 'intelligence quotients' originally developed by Binet to enable the Paris Education Authority to predict which children would fail in the school system. The fact that Binet and his successors, Wechsler and Burt, have been familiar names to elementary teachers for several decades underwrites the enormous impact IQ tests and normal curves have had on educators' views of pupil characteristics. Vernon (1959) summarized the essentials of the unfortunate way in which he perceived IQs to be interpreted by student-teachers and educationists generally:

> The I.Q. as measured by standard intelligence tests, applied in a standard manner, measures the child's innate intellectual capacity which is determined by his genes. This general ability or 'g' is the main factor underlying achievement in any direction, particularly in the educational sphere. Moreover, since this index of intelligence is very little affected by upbringing or environment, it enables us to predict, even in the junior school, the child's present and ultimate capacity for acquiring school learning and his suitability for a career involving high (or low) intelligence. If he is backward educationally and his I.Q. is low, we need seek no further explanation. (p. 3)

The high correlations between general knowledge and IQ scores (0.85 on the Wechsler Intelligence Scale for Children), and the finding that vocabulary scores are the best single predictors of intelligence (0.86 on the Wechsler Intelligence Scale for Children) provided clear indications that the genetic explanation of IQ was extremely suspect. In 1941, Wechsler himself pointed out that:

> the one serious stricture that can be made against the Vocabulary Test as a measure of a man's intelligence is that the number of words a man acquires must necessarily be influenced by his educational and cultural opportunities. (p. 1)

However, Wechsler's reaction to this stricture was to fob it off:

> Our experience has shown that the factors of schooling, <u>etc.</u>, [emphasis added] influence the effective range of an individual's vocabulary much less than is commonly suspected. (p. 2)

In spite of these issues the growth of evidence to counteract the view that pupil I.Q. scores predict school achievement because of predetermined genetic potential, has been a slow process.

Piaget's work in the 1920s demonstrated that none of our mental capacities is innately given but develops through exploration of and interaction with the environment. However, Piaget's work was not widely

read until the 1950s. His theory of learning incorporated detailed descriptions of mental processing through assimilation of new concepts to existing schema or the accommodation to new concepts through transformations of existing schema. Piaget's work comprised one of the earliest coherent, holistic theories of learning which was systematically supported by accounts of observable behaviour.

Nuthall (1974) pointed out that 'teachers who have studied the work of Piaget, or been required in their training courses, to read something of his research, will be aware that it does not say a great deal about how to teach' (p. 35). Piaget primarily studied children not pupils, and the influence of the classroom context on children's learning has not yet been adequately illuminated in empirical investigation.

Insights into pupil characteristics that relate to pupil achievement have emerged from diverse investigations over the past two decades. A number of educators have argued that fostering positive self-images in children is an important school function, (for example; Clark, 1963). Since the mid-sixties children's self-concepts have been found to be significantly correlated with school achievement (Brookover, Thomas and Patterson, 1964; Wattenberg and Clifford, 1964). Epstein (1973) has developed a theory of self-concept in relation to the promotion of pupil coping strategies which is supported by Cullen's (1981) study of pupil coping strategies when faced with initial task failure. Nevertheless the links between pupil self-concept and pupil achievement are difficult to establish and work in this field is in its infancy.

The growth of the classroom interaction research tradition, as has been discussed in relation to teacher effectiveness research, contributed an increasing focus

on pupil behaviours in relation to pupil outcomes. Dunkin (1978) suggested that joint contributions of pupil characteristics and process variables account for as much as 35 percent of the variance in pupil achievement.

However, the behaviourist legacy of an on-task/off-task distinction that is predecided has inhibited investigation of empirical links between pupil behaviours and learning outcomes. Johnson (1981) pointed to an underlying assumption which has contributed to the research failure to investigate potentially important pupil behaviours:

> It has been assumed by some that students' learning, socialization, and development are primarily dependent on their interaction with teachers; that peer relationships have little impact on the student and, therefore, could be ignored; and that the infrequent and minor peer influences that do exist in the classroom are an unhealthy and bothersome influence, discouraging academic achievement and encouraging off-task, disruptive behaviour in the classroom. (p. 5)

In effect, Johnson argued that pupil interactive behaviours, previously categorized as off-task were highly correlated with pupil achievement and he cited comprehensive evidence to support this claim.

In spite of the inhibiting effects of assumptions about the functions of pupil behaviours there has been a steady growth of research focus on pupil behaviours and latterly on pupil perceptions. Winne and Marx (1980) reported the high frequency with which pupils perceived teacher instructions inaccurately. Anderson (1981) investigated pupils' insights into the purpose of their assigned seat-work. She found that the pupils perceived the object of their efforts to be production rather than learning. Bloome (1981) Blumenfeld, Pintrich, Meece, and Wessels (1982), Davis and McKnight (1976) Stake and Easley (1978) and Doyle and Carter (1984) have also investigated students' perceptions of subject matter and classroom tasks. These studies showed a prevalent concern amongst pupils and teachers for maintaining order in assignments, and producing and completing assignments rather than for learning concepts.

Recent research has shown not only that pupils experience confusion about the nature and goals of classroom tasks but also that pupils are inhibited from learning by their misconceptions about relevant content (Brophy, 1982; Eaton, Anderson, and Smith, 1984; Osborne and Wittrock, 1982).

In conclusion, although research into pupil characteristics was extant in the 1860s the investigation of the links between pupil classroom behaviours and pupil learning has been a recent phenomenon. The burgeoning of such research in the past five years attests to the increasing fruitfulness of this field of investigation, not only with respect to direct issues of pupil learning but also with respect to understanding teacher effects and the effects of teaching methods.

1.6 SUMMARY

In 1980 Good stated:

> We know little about how students learn and how teachers in schools can facilitate learning for students generally or for specific types of students. (p. 1)

Research has not adequately illuminated our understanding of pupil learning in classrooms. The least fruitful research in these traditions has involved dogmatic adherence to inappropriate methodologies. It is indeed unfortunate that much of the research reviewed in this study has been prematurely translated into guidelines for practice, particularly given the paucity of wisdom in the empirical findings when compared with the best of common sense practice. The outrage of practitioners has been eloquently voiced by commentators such as Jackson (1978). Even commentators who have found recent findings useful for teacher training (for example: Borich, 1979) have called for more attention by researchers to causal explanations of pupil learning.

On the other hand, commentators at the present time do have more basis than those at the turn of the century for claiming that the research enterprise has much to offer teachers. The growth of alternative methodologies evident in the recent investigations of pupil learning in classroom task contexts, the widespread movement away from investigations of isolated variables toward a more holistic conception of the research endeavour in classrooms, and the evidence of increasing professional dialogue between researchers and teachers (Schwab, 1983; Shulman, 1984) point to a new and exciting phase in

classroom research.

There is evidence that advice such as that given to researchers by Harnischfeger and Wiley (1978), 'research must simultaneously consider pupil activities, teacher activities, and the content of the learning situation' (p. 46), has strongly influenced investigations of pupil learning. The next step is to ensure that our investigations address the critical issues of the way in which classroom processes involve interactions between home and school variables. The evidence that there are important interactions between factors such as pupil socio-economic background, parent education, class composition and pupil achievement in school can no longer, in conscience, be disregarded by researchers investigating pupil learning in classrooms.

This review has attempted to identify the implications of the research for present studies of learning and teaching in classrooms. The 'state of the art' influenced the kind of questions asked in this study, and the exploratory orientation adopted. It led to a primary concern with the pupil in the classroom setting, an attempt to identify the confounding effects of content and context variables, and a design that would facilitate the discovery of school-home interaction variables. This necessitated the development of a methodology appropriate to investigate pupil learning in classrooms. The evolution of this methodology , and its rationale, are discussed in Chapter 2.

CHAPTER 2

METHODOLOGY

> If the picture we obtain from the data is confusing and ambiguous, then our attempts to explain it must be correspondingly ingenious and creative. It is foolish to give up because an immediate pay-off is not evident. Surely if the scientific enterprise means anything in the educational context, it does not mean quick returns in research-based platitudes, but a procedure for coming to understand the genuine mysteries that confront us.
>
> Nuthall, 1974 (p .16)

2.1 OVERVIEW

The methodology of this study is non-traditional. It has been designed to investigate the questions:

> What facilitates pupil learning in classrooms?

and

> What is the nature of pupil learning in classrooms?

In chapters three to six the procedures used in this study are outlined in detail. In this chapter the evolution and rationale of the methodology are discussed in relation to the research questions. First, however, the design of the study is briefly outlined to provide the reader with a point of reference for understanding the methodological arguments.

2.1.1 Summary of Procedures

Three Standard Three pupils were continuously observed for 42 hours (during seven school weeks) which was the duration of an integrated science unit. Three observers systematically alternated in watching the three pupils. A continuous description of all the observable behaviours of each pupil was recorded by the observers. Detailed notes were kept about the context in which the behaviours occurred and recordings were obtained of verbal content (audio), pupil work (actual copies) and resources (photocopies, transcriptions and actual copies). Observer interpretations of pupil behaviour were recorded separately.

The pupils' prior knowledge, and immediate and long-term learning outcomes were measured using multiple-choice and open-ended tests of unit content. The basis for these tests was the content outlined by the teacher in pre-unit planning meetings with other teachers and recorded by the teacher in written plans. These tests were supplemented by in-depth interviews conducted immediately after the long-term posttest one year after the unit. The tests were also administered to other pupils in the class and to three other classes to provide general information about the effects of the unit and/or the test on other children.

A file was constructed for each case study pupil for each of 90 test items. Each file included data on every half minute of the unit during which the case study pupils had an opportunity to interact with content relevant to the test item. In effect, the 90 files described total pupil opportunity to interact with the content of the test.

Predictions of unit learning were made by both the teacher and researcher for each pupil on the basis of pretest scores and the description of total opportunity to interact with the content of that item. This procedure was employed before the quantitative analysis to provide information about the accuracy of teacher and researcher intuitive or naive beliefs about classroom learning and to provide insight into the kinds of researcher bias which might unduly influence analysis procedures.

The analysis of predictions against actual test results showed a high rate of prediction success but revealed systematic biases in both researcher and teacher assumptions that were not borne out by the test results. Consequently virtually all pupil behaviours were counted and analyzed in relation to pupil outcomes.

The analysis procedure was carried out in three steps before the overall analysis was collated. The data was divided into three randomly selected item file sets and relationships between behaviour frequencies and pupil learning in each set were calculated. Then the results for each data set were compared to establish the consistency of relationships within the study.

Two further analyses were carried out.

1.) The relationship between out-of-class experience and pupil learning was analyzed. This was done because the prediction procedure revealed a systematic link between direct pupil experience and long-term learning.

2.) Exceptions to the general pattern of learning results were systematically examined. The data on content which was mislearned or not learned in spite of considerable pupil opportunity to interact with that content were analyzed. In addition, the data on content which was learned in spite of little pupil opportunity to learn were analyzed separately to identify particularly effective teaching-learning situations. Patterns of pupil behaviour associated with these situations were checked against pupil memories for how they learned this content.

Throughout the analyses perceptions of the participants obtained from the interviews were triangulated against the quantitative findings and the test results.

A nascent theory of learning and teaching was constructed from, and grounded in the data. This explanatory theory was derived from the patterns of pupil behaviour associated with short-term learning, long-term learning and failure to learn.

2.1.2 Background and Overview of this Chapter

The basis of the methodology was developed in a pilot study, 'Pupil Learning in Relation to Teacher Aims and Pupil and Teacher Activities During an Integrated Class Unit - A Philosophical Empirical Study' (Palmer, now Alton-Lee, 1978). However, the methodology continued to evolve in the course of the present study.

The methodology should primarily be evaluated by the results of this study. That is; how fruitful is the methodology in producing results that are useful answers to the questions posed at the beginning of the chapter. In order to interpret the results, however, it is necessary to establish the scientific defensibility of the methodology. Procedures adopted in this study have been borrowed from educational, sociological, psychological, anthropological and classical science research paradigms. They have been used to obtain both quantitative and qualitative data.

The rationale for the research questions is outlined in section 2.2 and the questions asked in this study are contrasted with research questions asked in related research.

In section 2.3 the constraints the research questions imposed on the design are discussed and in section 2.4 the procedures adopted in the study to make covert researcher, observer and teacher assumptions explicit are outlined and discussed in relation to the ways in which bias was either eliminated or exploited to enrich the data obtained. The primary importance of validity in this study is argued in section 2.5 and the procedures employed to establish both validity and reliability in the study are described.

In section 2.6 the limitations of the study with respect to traditional approaches to generalizability are outlined. The potential fruitfulness of this kind of study for a more useful approach to generalizability in classroom research is argued.

A justification and rationale for theory building from the findings of this study are presented in section 2.7 and the status of the theory generated is discussed. Finally, in section 2.8, the methodology is reviewed

and contrasted with experimental, correlational and qualitative paradigms in educational research.

2.2 RESEARCH QUESTIONS

The first question: 'What facilitates pupil learning in classrooms?' differs primarily from traditional questions asked in classroom research in that it is an open question. In contrast to the traditional hypothesis or hunch employed at the outset of an investigation that 'X' is related to pupil learning, this study leaves open the question of 'What sort of 'Xs' should classroom researchers be focusing on?' Given the meagre state of research understanding of classroom processes and pupil learning, a methodology oriented to exploration is more defensible than a methodology oriented to hypothesis testing or confirmation.

The question asked does not assume a direct link between teacher behaviours and pupil learning. As was apparent in Chapter 1, classroom research has been characterized by an almost exclusive emphasis on teacher effects. However, the results reported in the literature are confounded by repeated evidence for the inconsistency in relationships between teacher characteristics or behaviours and pupil learning.

The relationship between teacher behaviours and pupil learning is mediated by pupil behaviours such as attending and processing. Harnischfeger and Wiley (1978) have argued the case for focusing on pupil experience (including pupil perceptions and behaviours) as critical in mediating all other variables in relation to educational outcomes:

> ... classroom learning processes determine pupils' learning experiences. And influences on pupil achievement must be mediated through these experiences. No one can gain knowledge or take up new ways of thinking, believing, acting or feeling except through seeing, looking and watching, hearing and listening, feeling and touching. ...The pupils' learning experiences ...are the sole proximal and distinctive determinants of achievement. (p. 48)

If we are to investigate the influence of teacher behaviours on pupil learning it is clearly indefensible to ignore the critical mediating influence of those variables. By focusing on pupil experiences and behaviours we may come to understand the relative influence of teacher behaviours more clearly.

There is also evidence that other variables such as mother's education, socio-economic status of the family, and the proportion of high achievers in a class (Beckerman and Good, 1981; Plowden, 1965; Rutter, 1979) impinge significantly on children's classroom achievement. In order to find out how these other variables may interact with teacher behaviours to influence children's classroom learning, it is logical to focus on the person in whose behaviour we are most likely to find evidence of this influence; that is, the pupil.

The second justification for asking this research question is that it addresses the overt purpose of schools; to bring about pupil learning. Many classroom researchers (Beckerman and Good, 1978; Merrett and Wheldall, 1978; Gump, 1981; Stebbins, 1980; Tymitz and Omark, 1978) have

used pupil behaviour in the classroom as the criterion for teacher effectiveness. But as Kyriacou and Newson (1982) pointed out:

> Pupil behaviour in the classroom is the means to achieve certain ends not the ends themselves...Indeed, a number of researchers (e.g. Denscombe, 1980a; Woods, 1979) have warned of the dangers of assuming that teachers who are able to maintain high levels of pupil on-task activity are in fact more effective. (p. 7)

The process behaviour most commonly referred to as an outcome is 'on-task' behaviour.

'On-task' behaviour can be an end in itself if we regard behaviours such as pupil obedience and persistence with set tasks as valuable outcomes. However, in some situations, on-task behaviour (for example; silence) may inhibit pupil learning. The conflation of pupil classroom behaviour with educational ends in the research reflects the view of teachers that certain behaviours are unquestionably linked with pupil learning. We have no substantial body of evidence to support this link and some pupil behaviours (for example; fiddling) have not been empirically investigated. Thus, the claim that a pupil is 'on-task' is an inferential claim about mental processing that warrants investigation.

Even if on-task behaviour is valued as an end in itself, then educators making such a value judgement should be informed about the relationship between behaviours regarded as off-task or on-task and short- and long-term attitudinal and cognitive changes in pupils.

2.3 CONSTRAINTS

The research question, 'What facilitates pupil learning in classrooms?', did impose certain requirements on the methodology employed in the study. The major requirement was to obtain fully detailed information about the in-class learning opportunity of individual pupils. A related requirement was the need for continuous recording rather than time sampling procedures. The research question also required a naturalistic focus on a self-contained section of a classroom programme.

2.3.1 Individual Pupils

The focus on individual pupils followed as a practical and theoretical consequence of the research question. In order to discover the major variables which affected pupil learning it was desirable to obtain information about as many as possible of the universe of Xs (events occurring in the classroom that are perceived, attended to, or engaged in by the pupils, or events occurring outside the classroom which impinge upon in-class events) which could potentially affect pupil learning.

In traditional design the number of Xs is relatively small and pre-decided and the number of pupils or classrooms is high. Also, the amount of data collected about each X or variable is limited to only a few samples. In this study the number of Xs was high (over 50 variables associated with pupil behaviour were identified and systematically analyzed in relation to pupil learning) and the number of subjects was limited to three. For each subject, however, over 5000 units of direct observational data were obtained in addition to other non-observational sources of data. This data

provided a continuous and relatively complete picture of pupil experience of a class programme.

To obtain comprehensive information on the universe of possible events one observer was needed to make continuous recordings of the experience and behaviour of each pupil. The limitation of three subjects was imposed by the teachers in both the pilot study and the present study. They indicated that three observers would be the most they could have in their classrooms without disturbing their classes.

There are significant precedents for studying a small number of subjects in the work of Piaget and the classical studies of language development in children (Brown, 1973; Miller, 1979). However, large samples have been considered mandatory in process-product investigations of classrooms. Brophy and Good (1983) excluded studies of only one class from their review of teacher effectiveness on the grounds that such studies would not be 'likely to generalize to typical elementary and secondary school settings' (p. 2).

Although generalizable findings have not been forthcoming, researchers have remained committed to the principle of large numbers of subjects and the potential advantages of tracking the learning of individual pupils have not been investigated. The tracking of individual pupil behaviour in this study, made it possible to obtain a relatively complete record of the universe of observable behaviours which occurred during the total in-class opportunity for pupils to interact with specific content.

As a result of this approach two important advantages over traditional classroom research methodology were possible. First, it became possible to systematically associate pupil behaviours with the context within

which they occurred. Because each child in a classroom experiences a unique sequence of contexts depending on when and how often he or she interacts with the teacher, other children, instructional materials, or leaves the classroom, studies which treat the whole class as a single unit or record only teacher behaviours do not record the actual context experienced by any one of the children. In contrast, a total record of individual pupil opportunity to interact with content makes possible an investigation of the role of context in influencing the function and meaning of behaviours. For example, the data obtained showed a different relationship between pupil rubbing out (erasing) behaviour and learning in individual task contexts compared with group task contexts.

Second, the complete empirical record of the range of pupil behaviours in relation to learning outcomes made it possible to identify the relative importance of specific behaviours within the overall pattern. In traditional process-product research, learning from interaction with peers may occur incidentally but the assumption that the teacher's behaviour is the variable of interest hides such effects.

Classrooms are complex settings in which all pupils do not have identical experiences. The most useful gauge of the strength of the relationship between one variable and pupil learning will be obtained when research provides information about the relative effect of that variable in relation to the universe of other variables which typically occur. Focusing on the learning of individual pupils enables the researcher to document not only the range of variables influencing learning but also their inter-relationships.

2.3.2 Continuous Observation

The employment of continuous observation rather than time sampling procedures was perceived to be a requirement imposed on the study by the research question. The rationale for continuous observation has already been partially addressed in the previous discussion about context effects and the relative effects of different variables on pupil learning. The focus on individual pupils is inextricably related to continuous observation. Three further issues rendered continuous observation a methodological requirement: the need to identify (by elimination) out-of-class influences on in-class achievement, the commitment to minimize bias in data selection, and the necessity for continuous data to enable plausible causal inferences to be made about pupil learning.

2.3.2.1 Identification of Out-of-Class Influences on Pupil In-Class Achievement

A complete record of pupil opportunity to interact with specific content during the unit made it possible to identify by elimination the influence of out-of-class factors on pupil in-class achievement. For example, factors such as pupil experience on a family excursion and current affairs discussions at home were found to have facilitated pupil learning outcomes.

2.3.2.2 Minimizing Bias in Data Selection

In order to keep the research question as open as possible it was necessary to minimize researcher selection bias in the data gathered.

Time sampling introduces a selection bias that is unwarranted by our present understanding of classroom processes. The occurrence of a behaviour may be of less significance than its duration and function. Yarrow and Waxler(1979) argued:

> The properties of behaviour, specifically of social behaviour and of interaction, that seem to us of first line importance in decisions of measurement are the following: Behaviour is continuous. Identification of parts is difficult for the reason that an act or sequence of acts in a stream of behaviour has (simultaneously) different defining characteristics or properties....
>
> The particular research question increases or diminishes the salience of various behavioural properties. But with the essential properties always in mind, we stand a better chance of obtaining data that are least distorting of behaviour and that optimally address the research question. (p. 39)

Yarrow and Waxler also pointed out the truism that 'behaviours are not distributed regularly along time; they are linked to time in various ways' (p. 38). A continuous record of pupil behaviour facilitated an exploration of qualitative dimensions of the relationship between specific behaviours and pupil learning, after the quantitative analysis had been carried out. The continuous record of pupil opportunity to interact with content over the actual amount of time spent also facilitated an exploration of the ways in which relationships between specific behaviours and pupil learning were related to, or confounded by, the time spent. Rather than imposing characteristics on the behaviour by time sampling, the methodology rendered the relationship between pupil behaviours and time, potentially at least, an open question.

Clearly, even the most detailed description of observed behaviour is only a sample of actual behaviour and observer bias can influence the kind of sample obtained even when continuous recording procedures are employed. The methodological procedures developed to minimize these problems are described in detail in the sections on bias and validity later in this chapter.

2.3.2.3 Causal Pathways

In traditional process-product research design, total or gain scores on tests are employed as if those scores provide a representative index of a single pupil outcome. However, pupils generally respond correctly to some items that were 'taught' and incorrectly to other items that may have been 'taught' . If we regard classroom experience as a

single treatment and a gain score as a single outcome we preclude the finding that parts of the treatment may have been effective with respect to some content and parts of the same treatment may have been ineffective with respect to other content.

By tracing total pupil opportunity to learn the content of a particular item and then differentiating out data for items not learned from items learned and remembered and items learned and forgotten for individual pupils it was possible to identify the actual conditions consistently associated with long-term learning , short-term learning , failure to learn and mislearning.

Furthermore, the continuous records made possible the identification of sequences of behaviour associated with particular outcomes.

Thus continuous observation, by minimizing inferences about observable behaviour, and providing data about total sequences of behaviours and conditions associated only with particular learning outcomes, enabled carefully substantiated causal inferences to be made about patterns of pupil behaviour and learning.

2.3.3 Naturalistic Framework

The research question, 'What facilitates pupil learning in classrooms?', required a naturalistic framework and influenced the selection of teacher, class programme, and the time period for the study.

The question assumes that learning does occur in classrooms and it assumes an investigation of 'naturally occurring' learning in classrooms.

2.3.3.1 General Rationale for a Naturalistic Framework

Although the findings of the large-scale school effects studies, such as those reported by Coleman et al. (1966) that independent school effects contributed minimally to the variability of pupil outcome scores, have been interpreted by some to mean that schools make 'no difference', the fact that schools and teachers do make large differences in pupil knowledge and skill acquisition is well documented. That the difference made does not significantly alter the rankings of pupils relative to their initial scores but rather has a fanning effect (Coleman et al., 1966; Heyns, 1978) on their initial rankings is quite a different issue.

Children undergo changes in classrooms that affect their immediate well-being and their future life chances. We need naturalistic studies to investigate extant processes which bring about change in pupils and the kinds of changes that come about, whether they be intended or unintended by the teacher. Given the acknowledged paucity of our understanding of intended or unintended learning and teaching in classrooms (Gage, 1982; Good, 1980; Heath and Nielson, 1974) and the knowledge that learning does occur in classrooms, it would seem that an investigation of the how and why of what <u>is</u> occurring would be a more defensible starting point than an intervention. Jackson and Kieslar (1977) argued:

> We tend to forget that a firmer rationale for current practices might prove a greater boon to the vitality of educational efforts than would an entire compilation of suggestions about how to improve this or that pedagogical technique. (p. 15)

A naturalistic approach allows investigation of a wider range of potential variables than a traditional approach. Given the lack of theory and the absence of unequivocal findings about children's learning in classrooms, a naturalistic approach is appropriate because variables of interest do not have to be pre-selected. Further, it enables an investigation of inter-relationships between variables and the identification of significant context effects.

Because a naturalistic approach allows context effects and inter-relationships to be <u>discovered</u> and investigated in relation to participant meanings, it can serve a critical function in illuminating the snowballing effects which are likely given an intervention. Naturalistic research should be carried out before prescriptions for practice are made.

Fenstermacher (1978) pointed out that researchers traditionally make an unwarranted slip between three questions:

> Q1 Do teacher performances P1 and P2 result in success at task K1 by students assigned to this task?

Q2 Why do P1 and P2 result in student success at K1?

Q3 What should teachers do in order to be effective in getting students to succeed at K1 and tasks like it? (pp. 163-164)

Fenstermacher commented that:

> By coupling a few assumptions and presuppositions with a knowing wink at the absence of explanatory theory, all three questions get knocked off the playing field in the haste to move from modest correlational findings to imperatives for teacher training.
>
> (p.165)

Berliner (1978) dramatically illustrated this slip when in one of his interventions in four classrooms, designed to decrease transition times, he actually increased transition times.

In order to: (a) obtain answers to the <u>why</u> questions which are valid explanations in relation to the complexity of classroom experience, and (b) identify the <u>range</u> of considerations teachers have to take into account to facilitate student success with classroom tasks, it is necessary to carry out naturalistic investigations.

Given a more comprehensive understanding of the ways in which the range of classroom variables as mediated by pupil behaviours affect pupil learning outcomes there can be two important consequences.

First, we can gain an understanding of what unintended or hidden influences operate in a classroom.

Second, it will be more defensible and more feasible to develop experimental and interventionist studies which maximize all the variables which will facilitate pupil learning. By grounding research in good practice it may be possible to derive findings which can point to even better practice which does take account of the natural constraints of the classroom setting.

It is clearly necessary to gain understanding about the processes by which schools, classrooms and teachers contribute to effects such as the fanning effect on pupil achievement before we rush to provide the schools with interventions that may promote outcomes which have questionable value.

2.3.3.2 Implications of the Naturalistic Approach for the Study

2.3.3.2.1 Teacher Selection

First it was necessary to select a competent teacher in whose programme at least some significant pupil learning was occurring. It is obvious that an investigation will be likely to identify variables which are facilitating pupil learning only if the pupils studied are learning.

2.3.3.2.2 The Unit

Second it was necessary to identify a self-contained section of the class programme where specific content would be taught. The decision to investigate pupil learning during a unit of work was made for the following reasons.

In the type of school in which the study took place, units are self-contained 'packages' of classroom programme which focus on particular topics. Generally, very little planned overlap between units occurs. Units include both teacher-directed lessons and pupil activity or 'seatwork'.

In essence, a unit is a virtually complete, naturally occurring treatment condition which is quite distinct from other aspects of the school programme before, after, and during its implementation. Both the teacher and pupils perceived the unit studied to be a distinct part of classroom life. The teacher planned in units and the pupils were accustomed to beginning unit booklets at the outset of a new unit and finishing these booklets by the end of a unit.

One year later the pupils referred to 'the Conservation Unit' as an entity separate from other aspects of the class programme.

Furthermore, although units have not been widely investigated in classroom research they have historically been more prominent in classroom practice than the almost exclusive focus on teacher-directed lessons in the research would suggest.

Dewey's opinion that Herbart's five-step lessons were an artefact of theoretical pedagogy, not actual practice, was widely supported early this century. In 1916 Professor R. L. Archer pointed out that "We have all abandoned the cult of 'chalk and talk'; we all believe in the efficacy of the pupils' activity" (p. 246). In the 1930s papers such as Biddick's 'The Preparation and Use of Source Units' were prevalent in pedagogical literature. Geyer (1936) and Tate (1936) published reviews of studies which showed the superiority of 'activity', 'project' and 'integrated' programmes over 'traditional' teaching. And by 1950 in the National Society for the Study of Education Forty Ninth Yearbook Burton elaborated on the unit as the optimal means of organizing instruction.

Only recently, however, have research reviewers commented on the failure of classroom researchers to investigate the unit. Brophy and Good (1983) in making suggestions for future research argued:

> To study these issues of instructional redundancy, integration of concepts, and teachers' processing and use of information gathered during teaching,

> researchers will have to focus on the instructional unit rather than the lesson as their unit of analysis and to observe over several consecutive days rather than spread observations across the term. (p. 127)

Not only are units widespread in educational practice but also they constitute the customary way for teachers to organize curriculum knowledge in science, social studies, and sometimes in other curriculum areas such as language. Because the teacher not only selects the 'methods' through which children experience content but also selects what constitutes the content or knowledge of a unit there is considerable variation in the content to which pupils are exposed. If, as Glass(1972) proposed, the nature of content must be an important ingredient in our understanding of the teaching-learning process, then the unit is a logical focus for investigation.

The question of relative influence of teacher-directed lessons and pupil follow-up activity on pupil learning is a vexed question. Researchers have traditionally focused solely on teacher behaviours during teacher-directed lessons in spite of the cited evidence that pupil activity has been a significant aspect of classroom practice since the turn of the century.

Kyriacou and Newson (1982) distinguished the traditional teacher-directed lesson from 'naturally occurring lessons' and argued against studies of these 'naturally occurring lessons' for the following reasons:

> starting with naturally occurring lessons poses problems...For example, a study of a lesson in which a variety of methods are used (e.g. Anderson and Scott, 1978) cannot validly allow their independent effects to be estimated. If teachers who use a lot of 'seatwork' are most effective, this may say more about the teacher and his class than about the method. (p. 9)

The overwhelming concern of Kyriacou and Newson with independent effects in process-product research is typical of the view which has inhibited researchers from investigating the very patterns of class organization which have recently been identified as typical of the most effective teachers (Brophy and Good, 1983).

One further advantage of the focus on a unit was that in addition to the unit comprising a naturally occurring 'treatment', unit posttests to measure pupil knowledge were also a customary practice in the class studied. Thus a posttest could be administered as a naturalistic 'intervention' to obtain information about learning outcomes.

The children were not familiar with unit pretests, however, and the teacher was asked to administer the unit pretest in order to minimize the impact of this unfamiliar procedure upon the children. The administration of a pretest was the only intervention, apart from the physical presence of the observers and recording equipment, that was made in the classroom

programme during the period the children studied the unit.

2.3.3.2.3 Time Period of the Study

The time period for the study was the duration of the unit. Although the teacher predicted that the unit would last for three to four school weeks, it took seven school weeks.

2.3.3.2.4 Learning Outcomes

The outcome variables in this study were selected on the basis of the teacher's planned outcomes which were predominantly knowledge acquisition and attitudinal changes.

2.4 BIAS AND ASSUMPTIONS

Researcher assumptions, particularly those that influence the kinds of data selected, are hidden variables in most investigations. Methodological assumptions can become obscured in traditional practice. For example, it is often assumed that traditional methods of classroom research meet the requirements for true random sampling which are necessary for statistical significance testing. However, Cornfield and Tukey (1956) argued that randomness is never achieved in educational research sample selection.

In this study careful procedures were developed to try to reveal researcher and observer assumptions. In the following section these procedures are outlined and reasons are given for those conscious assumptions which guided the methodology but which were not strictly constrained by the research questions.

2.4.1 Participant Bias

The perceptions of the teacher, the case study pupils, and other pupils were viewed as data. Participant viewpoints were regarded as more valid data selection factors than the viewpoint of the researcher. For example, it was the teacher's perception of desired learning outcomes which was the basis for the unit tests.

Both pupil and teacher views were triangulated against the quantitative analyses of the observational data. Quantitative findings which were confirmed by pupil memories of the unit or perceptions of their ongoing experience were considered to be very strong findings. Pupil and teacher perceptions which contrasted with the findings of the quantitative analyses were considered to provide important insights into the social meanings, and in some cases the mythology, of the classroom.

2.4.2 Observer Bias

The purpose of this study was to <u>discover</u> the function of pupil behaviours in relation to pupil learning. The discovery orientation was continually in jeopardy because the observers had a priori theories about the relationship between pupil behaviours and learning.

The fact that classroom observers have been participants in classrooms as pupils and thus, to some extent, share the a priori theories of the participants is an issue that was addressed in this study.

Procedures for suspending a priori theories in order to make discovery of empirical relationships between pupil behaviours and subsequent learning possible, have not been developed in the literature. As McCutcheon(1981) noted:

> While several methodologists have discussed observation (e.g., Barker, 1968; Smith, 1968), less has been written regarding interpretation, that is, the meaning of observations and the process of making that meaning. (p. 5)

The process of making meaning of observations in this study entailed finding out which behaviours were empirically related to pupil learning. In order to answer this question it was necessary to train the observers to record comprehensive descriptions of pupil behaviour which were minimally influenced by observer or researcher selection biases or interpretive biases. However, as Erikson (1978) argued:

> narrative description of social relations contains within itself a theory of the events it describes; that no description is mere description. (p. 1)

The development of a minimal inference observational procedure was critical to the success of the study. The following procedures were employed to achieve this.

2.4.2.1

The observers were requested to record all pupil opportunity to attend to teacher talk or a visual or auditory resource. Thus the observers were not required to make, or agree on, inferences about when a child was actually attending. If a case study pupil spoke to his or her peer during an opportunity to attend to teacher talk, no inference was made that that pupil was failing to attend. If a child was focusing on a hairclip and fiddling with it during an opportunity to attend to teacher talk no inference was made about failure to attend.

The subsequent analysis of pupil behaviours during the opportunity to attend revealed which behaviours were highly related to learning. These behaviours were postulated to involve attending in the light of their systematic association with pupil learning outcomes.

2.4.2.2

One of the ways in which systematic bias has accumulated in classroom observation studies has been the tendency to record only one behaviour at a time. Observers have been required to select the most important or dominant behaviour over a time period and record just that behaviour. In this study the fact that the pupils frequently engaged in a number of observable behaviours concurrently became clearly apparent. Observers were required to minimize this kind of selection factor and record all concurrent, observable and potentially meaningful behaviours.

2.4.2.3

Observer interpretations of pupil behaviour were recorded in a separate column on the recording sheet. Observers were asked to record their views about how the behaviour patterns they had observed would relate to pupil learning. Thus, the observers would make comments such as 'seemed tired', 'wasted time' or 'really appeared to be interested in the lesson' in order to provide an insight into the relationship between a priori theories of pupil learning behaviours and the empirical evidence.

As two of the observers in this study had been teachers and one had not, the interpretations of the observers provided interesting insights into differing a priori theories.

As a final measure, the observers alternated in watching the case study pupils. This procedure enabled differences in observer perceptions to be exploited as data without systematically biasing the data on any one of the case study pupils.

2.4.3 Researcher Bias

A prediction procedure was developed to provide insight into hidden researcher biases which may have influenced data selection and analysis procedures.

The item files were sub-divided into three randomly selected sets before the data was systematically analyzed. The researcher engaged in a prediction

procedure which involved identifying each case study pupil's pretest response, examining the synchronized transcript of pupil behaviour in relation to the content of that item, and predicting immediate and long-term outcomes. The teacher was also asked to carry out this procedure for a proportion of the item files. An analysis of researcher and teacher predictions against actual test and interview responses revealed patterns of bias which were generally similar for both researcher and teacher. The prediction procedure was revised and repeated with the second prediction set and with the third prediction set. These findings are reported in Chapter 6.

An additional informal procedure was used by the researcher to identify potential researcher bias in the analysis of data. Two teachers were asked regularly to interpret and critique the findings at different stages of the analyses. Two other teachers including the teacher involved in the study were also asked to take part in this critiquing procedure from time to time. These conferences had three important effects:

(a) Researcher bias which developed during the analysis and writing stages was apparent to the teachers who emphasized other findings in their interpretations of the results. This informal procedure operated as a check on researcher selectivity.

(b) Quantitative results which the teachers could not readily relate to their own classroom practice were illustrated with specific examples.

(c)Findings which challenged widely-held teacher mythologies were repeatedly highlighted.

2.5 VALIDITY AND RELIABILITY

> Our discussion will be adequate if it has as much clearness as the subject-matter admits of, for precision is not to be sought for alike in all discussions.
>
> (Aristotle, Nicomachean Ethics 1:2) (McKeon p. 936)

2.5.1 Overview

Traditionally, in classroom research studies, validity has been clearly less adequate than the subject-matter would indeed allow. Category systems such as FIAC have been developed to simplify the observation task and to enable selected behaviours to be coded and recorded irrespective of contextual details, and sometimes irrespective of the content of the lessons.

Questions of reliability in classroom research have not been resolved (Jersild and Meigs, 1939; Medley and Mitzel, 1963; McGraw, Wardrup, and Bunda, 1972) partly because the questions about validity have been inadequately investigated.

In this study validity was the prime concern based on the assumption that valid and detailed data reflecting as closely as possible the reality of the children's classroom experience, would necessarily be reliable. In order to attain Aristotle's standard of adequacy it was considered necessary to achieve a level of validity that is historically uncharacteristic of classroom research.

Further following Aristotle's advice, the issue of precision was considered in relation to the subject-matter: pupil behaviour. That is, more observational precision than is customary in time sampling procedures was obtained where the nature of the observed behaviour allowed it. However, data was not eliminated because of this constraint. For example, the use of the category 'opportunity to attend'.

2.5.2 Validity

The primary methodological approach adopted to ensure validity in this study was the use of a number of methods to obtain data. This approach may appear too obvious to merit discussion yet a multi-method approach is not prevalent in the research or commentaries on research methodology. Kyriacou and Newson (1982) for example, identified the shortcomings of the 'three main approaches to examining classroom processes (systematic observation, participant observation, and questionnaire surveys)' (p. 3). At no point in the article did the authors suggest using combinations of these approaches as a course of action to overcome problems such as the inaccuracy of teacher reports of behaviour.

The current popularity of papers, and even texts, intent on distinguishing the unique characteristics of quantitative and qualitative paradigms (Bogdan and Biklen, 1982; Bryman, 1984; Hymes, 1977; Smith, 1983, Wilson, 1977) mitigates against the use of a multi-method approach.

In this study, observational procedures, audio recording procedures, questionnaires, tests and interviews were used to obtain data. The use of

observational data and actual products gathered by three observers and synchronized transcripts of public verbal content facilitated high validity in four ways.

First, the actual verbal content obtained from the audio-recordings was synchronized with the accounts of case study behaviour to provide a complete record of public pupil verbalizations, and opportunity to attend to content.

Second, the collection of copies of teacher resources used such as charts, pictures, articles and books enabled judgements to be made about pupil opportunity to interact with content even when that interaction occurred privately. For example, when a pupil studied a picture displayed on the wall.

Third, details about class incidents such as an interruption or a non-verbal teacher behaviour which were captured by only one observer could be used to supplement the records of the other observers.

Fourth, the observations of behaviours such as pupil writing behaviour could be supplemented, after the actual observation period, with the words written by the pupil during that period. The data obtained from observations were enriched with further detail and supplementary data sources after the initial observation process. With such detailed data, decisions about categorization or classification procedures could be made <u>after</u> preliminary analyses of the relationships between observed behaviours and outcome measures indicated the appropriateness of the categories.

The data obtained from the interviews also contributed to high validity. In the interviews, which were conducted a year after the initial study, the children

reported those aspects of the unit which they remembered and used to answer test items. This kind of data provided information about the meaning of classroom events to the pupils in relation to their long-term learning outcomes.

A multi-method approach not only provided different sources of observable data but also enabled the observed data to be supplemented by data which provided insight into the significance of the observed events to the participants.

2.5.3 Reliability

Several procedures were used to obtain indications both of the reliability of the data gathering procedures and of the stability of the findings.

The multi-method approach to data gathering which contributed to the high validity of this study also contributed to the reliability of the data gained. Errors or omissions in the data gathered could be corrected against other data sources. For example, if a child appeared to be writing but a later examination of his work showed that he had been completing an illustrated heading the observational data was corrected. If an observer failed to note the change from a class context to a group context, the other observer records, the tape recordings and the type of activity the child engaged in within the group context all provided information upon which to correct the omission.

There were situations when observers missed behaviours because of factors such as fatigue and obstructed views. This problem was inevitable given the

observational task of recording all observable behaviours but the consequences were minimal because of the multiple sources of information. The degree to which these omissions affected the results is a question answered partially, at least, by the results per se. Complete lack of reliability would inhibit findings of systematic relationships in the study.

The major procedure employed to establish the reliability of the data involved separate analyses of three independent sets of data. Quantitative analyses were carried out for each of three randomly selected thirds of the total set of item files to provide three results for each variable for each case study pupil. An analysis of variance procedure was carried out to establish whether the differences in variable frequencies between conditions (time spent on content learned and remembered, time spent on content learned and forgotten and time spent on content which was not learned) were substantial in relation to the variance in variable frequencies within conditions. The results for each variable provided an indication of the stability of the relationship between the variable and pupil learning within the study. This procedure was also used to analyze the stability of the relationships between each individual pupil's behaviour and his or her learning.

Stable relationships across the three independent data sets provided information both about the reliability of the data gathering procedures and about the stability of the relationship per se. Relationships that did not meet the criteria were further investigated in order to establish whether the differences between the three item samples reflected some more complex relationship between the variable identified and pupil learning.

Three further procedures for identifying unreliability in the data, by Spector (1984), were employed in this study.

First, Spector described the analysis of a subject's statements for inconsistencies as a useful checking procedure. In this study, pupil interview responses were checked against test responses, public in-class responses and the content of pupil permanent recordings (drawings and writing). For example, there were occasions when a case study pupil recorded an incorrect response on the long-term posttest when the interview indicated that the child did, in fact, know the correct answer.

The second reliability check described by Spector involves checking on inconsistencies in the context of the data. Extensive analyses were carried out on the data in this study to establish consistencies or inconsistencies in the relationship between pupil behaviour variables and task contexts. The relationship between context and pupil behaviour has been systematically reported in Chapters 10 and 11.

A third procedure noted by Spector involves identifying the number of subjects' statements that do not fit into the researcher's conclusions. In this study, pupil interview responses were systematically compared with the quantitative findings. The fit between the pupil perceptions and the study findings was generally very high. These findings have been reported in detail in Chapter 12 but are also discussed throughout Chapters 9, 10 and 11.

2.6 GENERALIZABILITY

A critical underlying assumption of the use of inferential statistics in classroom research has been that there are behaviours which are related to pupil achievement irrespective of context variables. Glass (1972) claimed, in his classical paper on the problems of elucidatory inquiry in classrooms, 'that most teacher behaviour studies, indeed, even the best of them, have found relationships no stronger than the evidence for the ability of graphanalysts to assess personality through handwriting samples' (p. 11). Brophy and Good (1983) pointed out that although some teacher behaviours have been consistently found to be related to pupil achievement, there have not been consistently <u>significant</u> findings in this field. Glass concluded that the 'laws of the social and behavioural sciences are of extremely limited generality' (p. 13).

However, just because isolated, context-free behaviours have not been found to be particularly generalizable does not necessarily lead to Glass's conclusion. Rather, researchers may have been focusing on an inappropriate unit of generalizability. A central assumption of this study is that it is necessary to first identify the appropriate unit of generalizability.

As has been suggested earlier in this chapter pupil behaviours are more likely to be directly related to learning outcomes than teacher behaviours. Consequently, they are more likely to show generality across settings than are more remotely associated teacher behaviours. For example, one of the most consistent findings identified by Brophy and Good (1983) in their review was the relationship between teacher wait-time and pupil achievement. Teacher wait-time is, however, a measure of pupil processing opportunity, and may be more directly related to pupil learning than other teacher behaviours

which are not so closely linked to mediating pupil behaviours.

Phillips (1981b) argued that because of the Cartesian view of behaviour held in the process-product field, research on teacher effectiveness is likely to continue to be unproductive. Phillips went on to argue that until researchers take into account the meanings of behaviours any attempt to find generalizable results will be confounded by the inadequacy of the behavioural unit:

> The problem is that the one behaviour - the one bodily movement (a hand raised) - could possibly be any of a variety of actions. (p. 101)

The generalizable unit may be a combination of behavioural, context, content, and participant perception variables more complex than those traditional research has allowed.

The issue of generalizability in this study is particularly important because no mechanism for generalizability such as the use of inferential statistics has been incorporated in the design. Further, the use of three subjects following in a tradition of studies that favours a cast of thousands renders a defence necessary.

This study has been designed to identify the <u>kinds of variable clusters</u> which might be contenders for generalizability. The strength of the findings in this study based on their consistency across the data and across the case study pupils provides the index of their likelihood as contenders for generalizability. The search has been for relationships which are clear, fully detailed, and unequivocally true within the context of

this study.

The next stages in determining the generalizability of the findings would involve using similar methods to investigate classroom learning patterns for different pupils of different ages in different classrooms studying different content with different teachers.

Such investigations would establish the kinds of context limitations that exist on the generalizability of the findings. For example, the findings may be generalizable to pupils of the same age group in schools where children come from similar cultural and SES backgrounds. In effect, the issue of generalizability is taken to be an empirical question.

To attempt to establish generalizability at the same time as discovering the specific relationships that might be candidates for generalization is to confound the two processes. This study was designed to discover the relationships that occurred in a specific context, not to demonstrate that the context of this study is interchangeable with all other contexts.

In order to facilitate investigations of the generalizability of the findings of this study a theory of how learning occurred has been developed from the findings. Further, to facilitate investigations of the applicability of some of the findings to specific contexts by teachers, the teacher whose programme was studied and the researcher have devised an evaluation procedure for teachers to use to identify the key situations which promote learning in their own programmes; the Haberlee Evaluation Technique. This procedure is outlined in Appendix A.

A final argument is necessary to address the radical critic who would argue that because the results of this study are context bound and limited to only three pupils, they are by nature unique and therefore ungeneralizable. It may turn out that the results of this study are unique. However, if there is good reason to believe that the findings are valid for the context of the study, and the findings are unique, then it follows that pupil learning is uniquely tied to the context in which it occurs. This leads to the conclusion that the only kind of research that can be fruitful will involve investigations of individual pupils in particular contexts.

2.7 THEORY BUILDING

The second research question asked was 'What is the nature of pupil learning in classrooms?' Given an answer to the first question, 'What facilitates pupil learning in classrooms?', the function of the second question was to elicit a research answer that would make sense of the complexity of the findings obtained in answer to the first question, explain those findings, and provide the basis for the empirical investigation of their generalizability. The procedure used to answer the second question about the nature of pupil learning was theory building.

In this section the rationale for theory building about the nature of pupil learning from the findings of this study is given, the nature and status of the theory developed is discussed, and criteria for evaluating the theory are outlined.

2.7.1 Rationale for Theory Building

2.7.1.1 Explicit Theorizing as Responsible Research Practice

The first point worth making in defence of conscious theory building is that researchers traditionally engage in unwarranted theorizing. Much of the aptitude x treatment interaction research is interpreted using a priori theories of motivation and intelligence to explain why children with different aptitudes (as established using written tests) show different learning patterns. Unwarranted or unacknowledged theorizing has been viewed by some (for example, Harnischfeger and Wiley, 1978) as an atheoretical position. However, the use of motivational or intelligence explanations to interpret results of empirical studies is theoretical. The empirical data are used to support a position, albeit unacknowledged. In order to facilitate open discussion and investigation such assumptions should be made explicit.

The second argument, that inferential terms, such as 'on-task', which are used in data gathering embody unacknowledged naive theorizing, has already been advanced in this chapter.

The third argument is that researchers frequently make judgements about behaviours that were not observed in their studies on the basis of logical assumptions about the relationship between the observed behaviour and other behaviours of interest. This point has also been argued earlier in this chapter.

The fourth argument is related to the slip between findings and prescriptions for practice, identified by Fenstermacher (1979). This slip amounts to naive theorizing which is a matter of concern because, it may appear to the practitioner that the prescription is empirically validated. However, the processes which related teaching behaviours to pupil outcomes are not scientifically established. And certainly the relationship between research results and changes in practitioner effectiveness have not been investigated adequately. Until there is a body of knowledge about these relationships prescriptions for practice rest on unwarranted naive theories. The claim made by Evertson, Sanford and Emmer (1981) is just one example of this near universal slip:

> The findings of this study suggest that in-service programmes with a focus on classroom management would be especially useful for teachers with very heterogeneous classes. (p. 231)

Evertson, Sanford and Emmer (1981) did not investigate the efficacy of in-service programmes! Appleton, Hawe, Biddulph and Osborne's (1984) report on the difference between researcher conceptions of an intervention in a prescriptive booklet and the actual intervention of volunteer teachers confirms the unwarrantability of so many naive claims or assumptions about the translation of research findings into practice.

2.7.1.2 Complexity of the Findings

The findings of this study included quantitative and qualitative data on more than 50 variables occurring over 5000 half-minute intervals. Many of those variables were inter-related with respect to their influence on pupil learning. The generation of a theory served an important function in establishing the relative importance of specific variables or groups of variables and thereby simplifying the findings.

Related to this argument about the value of theory for making complex data comprehensible is the argument that theory building provided the study findings with a portability mechanism. The empirical findings were summarized theoretically as three main sets of factors which interact to facilitate pupil learning in classrooms. The theoretical argument about that interaction, and the nature of the factors, are more likely to be useful to teachers (to test within their own classrooms) than the extensive lists of empirical findings reported in Chapters 7 to 13. This portability mechanism is particularly important in this study because no mechanism has been incorporated to test the generalizability of the individual findings. The generation of a theory grounded in the findings enables teachers to translate the findings in their own classroom contexts where they can be treated as hypotheses requiring their own validation.

2.7.1.3 Explanation

2.7.1.3.1 Causal Links

> Since we are seeking this knowledge, we must inquire of what kind are the causes and the principles, the knowledge of which is Wisdom.
>
> (Aristotle, Metaphysics 1:1) (McKeon (p. 691)

In Chapter 1 the necessity for causal explanation was argued. Recently commentators have directly called for more researcher attention to explanation of their findings (Borich, 1979, Bloom, 1980; Glaser, 1982; Harnischfeger and Wiley, 1978; Suppes, 1974; White, 1984) Suppes stated:

> It should be to a greater extent, a primary thrust of theory in educational research to seek mechanisms or processes that answer the question of why a given aspect of education works the way it does. (p. 5)

And White asserted:

> Researchers are no longer content to know that treatment A affects variable B; they also seek to know how it happens. (p. 7)

Questions of explanation and cause have been vexed questions ever since Aristotle outlined different kinds of cause. In spite of the difficulties involved there is an important reason for attempting to identify causal relationships to learning in the field of classroom research. There may be numerous ways of facilitating pupil learning in classrooms that are equally effective. If we are able to identify <u>why</u> a set of circumstances facilitates learning then we are more likely to be able to identify alternative, and perhaps more effective, ways in which learning can be facilitated.

In this study various kinds of information about each variable were used to support hypotheses about the kind of relationship that existed between that variable and pupil learning. Several possibilities were considered with regard to the causal status of a variable. For example, the findings could indicate that a variable was a non-causal correlate of a causal variable, an enabling condition, or a causal variable. Emphasis was placed upon the inter-relationships between facilitative variables. The strength and stability of findings and their plausibility with respect to all the data were the primary criteria employed to support causal claims. For example, attending to pupil-teacher discussion was more strongly related to learning than attending to teacher talk. Thus, attending to pupil-teacher talk was a contender for a facilitative condition

in bringing about pupil learning.

Interview data revealed that the case study pupils believed other pupils' comments to be particularly worth attending to, and interview responses included memories for other pupils' utterances. However, the results also showed this variable to be systematically related to long term learning only when the pupils had relevant concrete experience and the opportunity to engage in follow-up activity. Thus, given pre-requisite and co-requisite conditions this variable (opportunity to attend to pupil-teacher talk) facilitated pupil learning <u>because</u> of the efficacy of the other pupils' comments for bringing about learning.

The final stage in developing an explanation for the relationship between a variable such as opportunity to attend to pupil-teacher talk and learning involved postulating the unobservable processes which such an opportunity systematically initiated. For example, enabling the attending pupil to make an appropriate cognitive link between a new concept and her own experience. The data indicated that the case study pupils were more likely to make appropriate links between new concepts and relevant experiences or prior knowledge given an opportunity to attend to anecdotes reported by peers rather than those reported by the teacher.

2.7.1.3.2 Unobservable Processes

Mclaughlin and Precians (1968-1969) pointed out that if unobservable entities did have real status then operationalism would inhibit the discovery of instruments to detect those entities. Given the importance of discovery as a function of this methodology a prior decision to rule out the possibility of unobservable entities would have been indefensible.

There is strong scientific precedent for this kind of postulation of unobservable entities in particle physics. The last decade of research in the field of sub-atomic particles has yielded the neutrino, the boson, and now the 'W' and 'Z' particles. The physical evidence of the existence of the first two particles mentioned has consisted of the observable traces of their interactions or collisions with other unobservable particles. Children's test responses can be viewed as observable concomitants of unobservable processes. The 'W' and 'Z' particles in quantum physics theory have not yet been observed; however, these postulated entities are accepted as plausible real entities which are, at present, unobservable.

Arguments for the importance of unobservable entities in psychology have been outlined by Fodor (1968), Heslep (1972), Heslep (1973), Mclaughlin and Precians (1968-1969), Rozeboom (1965) and Rozeboom (1970).

One reason for theory building in this study is the nature of the learning process. Learning is essentially an unobservable process. This means

that statements about this process cannot be made in the language of observable behaviour but must be made in terms of the unobservable elements of the process. Although these unobservable elements of the process may be directly related to observable behaviours or behavioural relationships, statements about the process can only be made on the basis of inferred or theoretical relationships between behaviour and process.

In the light of specific findings the attribution of cause to certain observable variables such as "pupil fiddling" would have been nonsensical. Hence, the postulation of unobservable mental processes associated with those observable behaviours provides a more plausible explanation of pupil learning.

The notion that learning involves unobservable processes was central to the participants' perceptions of, and explanations for, their own behaviour. This is apparent in the following excerpts from teacher talk during class and from pupil interview responses:

[remembering]

I just remembered it.

Emily

[thinking] [knowing]

Well, when I was looking at them (alternative answers in the test booklet) as I was reading them I thought, as I was going down I was thinking: yeah, that's one, yeah, that's one, and I was thinking that they was (sic) all ones. And I didn't know which one to put and then I saw the one about all of them.

Gus

[remembering]

And you might remember it from school and all of a sudden blah out the answer.

Gus

[remembering] [guessing]

I can't remember so I guessed

Diane

[thinking]

I just sort of thought; it clicked in my mind

Diane

[thinking] [feeling]

I might just think, oh yeah, I are (sic) getting a wee bit worried but that's all I'd think, you know. I wouldn't REALLY think about it.

Diane

[remembering]

I remember one day going to Mount Cook for the day.

Teacher (Day 3: 1.25'00")

[feeling]

Let's now think about the way we FELT. Those are just the comments you made, and some of them are comments which express what sort of feeling? What was the feeling you were actually showing?

Teacher (Day 17: 1.35'30")

[feeling] [imagining]

She was only fairly young when it happened. Get the feelings. Try and imagine her feelings.

Teacher (Day 12: 10.10'30")

[thinking] [imagining]

You think of some river or stream that you have actually seen.

Teacher (Day 20: 2.34'30")

[thinking]

What does it mean? Think about it.

Teacher (Day 11: 9.02'00")

[knowing] [thinking]

I'm just waiting for these young ladies over there to stop their fussing round. They might be able to tell me the answer instead of sitting there knowing very little. Start waking up their ideas!

Teacher (Day 10: 1.18'15")

These excerpts comprise only a small sample of similar statements made by the participants in this study. Both pupils and teacher referred to unobservable processing behaviours such as thinking, remembering, imagining and guessing, and to unobservable mental states such as knowing and feeling. Both pupils and teachers clearly distinguished between observable behaviours like reading and commenting and unobservable behaviours like guessing and thinking.

The teacher frequently requested the pupils to engage in unobservable behaviours (think!) In the final excerpt (Day 10:1.18'15") the teacher interpreted observable 'fussing' behaviour as a sign that certain pupils were in an inappropriate mental state (knowing very little) and required those pupils in metaphoric terms to initiate an unobservable process (start waking up their ideas) to bring about a desirable mental state.

The participants share the commonly held belief that mental processing is the key to learning and behaviour. This suggests the need to consider these constructs (beliefs) as significant factors. Further, the participants used a shared language to refer to both mental states and processes. They described these unobservable states as associated with concurrent observable behaviours. Thomas (1979) pointed out that the participants' 'theoretical' constructs are not in principle different from those of the scientist. By investigating the relationships between the observable behaviours the participants claimed to be associated with mental processing and actual

learning outcomes it was possible to provide systematic evidence for or against such constructs.

In this study patterns of observable pupil behaviour consistently associated with different learning outcomes, were checked against pupil reports of their unobservable behaviours. On the basis of this data a theory was developed to provide a coherent account of the unobservable mental processing which was associated with learning.

2.7.2 The Status of Theory in this Study

2.7.2.1 Grounded Theory

Theory which is generated from and grounded in systematically gathered empirical data in classroom contexts is not a characteristic feature of the research literature on classroom learning. Rather, as was discussed in Chapter 1, analytic theories such as those advanced by Aristotle, Plato, Rousseau and Montessori and theories developed from research conducted in non-classroom contexts such as those advanced by Piaget, Skinner and Ausubel have been the major contenders for inclusion in teacher training programmes.

The arguments for grounded theory have been developed in relation to social science research generally by Glaser (1978) and Glaser and Strauss (1967) and in relation to educational research into science teaching particularly, by Spector (1984).

The use of a grounded theory approach in this study differs from that described by Glaser (1978) and Glaser and Strauss (1967) in that the data collection was carried out before the hypothesis testing occurred. Given the complexity of the data and the use of outcome data it would have been impossible to carry out ongoing analyses in the manner outlined by Glaser and Strauss, during the data gathering procedures. Therefore a wide data gathering net was spread so that hypotheses generated retroductively could be checked out against other relevant data.

Grounded theory generation was particularly appropriate in this study because of the comprehensiveness of the data gathered about total pupil in-class opportunity to learn specific content. Because of this comprehensiveness inferences did not have to be made about observable behaviours.

Although theory generation was the primary focus of theory building in this study the potential for validation of aspects of other learning theories was exploited.

2.7.2.2 Nascent Status

The theory developed from the findings of this study is presented as a modest attempt to explain those findings. Haig (1979) argued a case for modest theory building:

> An appreciation of theories as developing entities with distinguishing features characterizing their various

> stages of development enables one to construct appropriate normative criteria for each of those stages...
> ...although I am for theory in educational research, I do not think with most of those who advocate theory that the demand for sophisticated, deep-running, high-order theories is the sensible, near-future alternative to radical empiricism.
>
> (p. 59)

Theory building in this study is an attempt to explain the learning of nine year olds in one classroom context. The next stage will be to test and modify the theory against the findings of similar studies in different contexts for pupils of the same age, and a later stage would be to test and develop the theory in different contexts for pupils of different ages.

2.7.2.3 Theory Evaluation

Given the nascent status of the theory the kinds of criteria appropriate to evaluate that theory would include initial plausibility, consistency, coherence and elegance with respect to explaining all the findings.

Because unobservable processes had to be postulated to explain observable behaviours the primary criterion for evaluation must be the plausibility of the postulated relationships between observable

behaviour and unobservable processes.

The theory should be evaluated in terms of its heuristic worth for generating further research.

2.8 METHODOLOGICAL STATUS

> The best research programmes will reflect intelligent deployment of a diversity of research methods applied to their appropriate research questions.
>
> Shulman, 1981 (p. 12)

The methodology adopted in this study is Aristotelian in that it is designed to answer the research questions. The approach is retroductive rather than inductive and oriented toward exploration rather than confirmation. The resultant methodology is quite different from that traditionally adopted in classroom research and is also different from the qualitative paradigms currently championed as appropriate for educational research. The arguments so far have contrasted this methodology with traditional practice in classroom research.

In the following section the methodology developed in this study is compared and contrasted with the qualitative paradigm. The point of this comparison is that adherence to this new paradigm may not maximally illuminate the kinds of questions asked by educators. Hence, the importance of a methodology which is developed in response to the questions asked.

2.8.1 Qualitative Paradigms

Bogdan and Biklen (1982) specified five characteristics of qualitative research in education. The methodology developed in this study is discussed in relation to each of Bogdan and Biklen's categories:

2.8.1.1 Qualitative research has the natural setting as the direct source of data and the researcher is the key instrument.

A naturalistic setting was the direct source of data in this study. But the researcher was only a key instrument to the extent that she selected the data to be recorded and analyzed and participated as one observer and as an interviewer. The researcher was deliberately supplemented by other instruments in order to gather more comprehensive data and to provide contrasting viewpoints to challenge researcher bias.

2.8.1.2 Qualitative research is descriptive.

Bogdan and Biklen explained 'qualitative researchers do not reduce the pages upon pages of narration and other data to numerical symbols' (p. 28). The data collected in this study was descriptive but it was also reduced to numerical frequencies and rates. The reduction of any data to a research report format is invariably numerical, if only in the minimal sense of the assertion that a phenomenon occurred more than once.

The qualities of description need not be lost through quantification. Indeed, when associated with qualitative and explanatory detail, quantification can enrich description. This principle is exemplified in the reporting of findings in this study in Chapters 8 to 12.

2.8.1.3 Qualitative researchers are concerned with process rather than simply with outcomes or products.

It has been argued in this chapter that the ends of schooling are of prime concern to the participants. One way, and perhaps the most important way of coming to understand the 'process' of classroom experience, is to understand how that process relates to outcomes.

Clearly the methodology of this study incorporated a central concern with the products as well as the process. However, concern with products does not per se undermine or impoverish an understanding of process. An understanding of process is enhanced by information about end products which serve to differentiate between processes and between stages in various processes.

2.8.1.4 Qualitative researchers tend to analyze their data inductively.

Bogdan and Biklen cited Glaser and Strauss's grounded theory as characteristic of qualitative research and as already discussed a grounded theory approach has been adopted in this study. Bogdan and

Biklen made the claim that the qualitative researcher 'does not assume that enough is known to recognize important concerns before undertaking the research' (p. 29).

The data from this study was analyzed retroductively. There were important concerns which guided the methodology. It seems difficult to understand why someone would engage in research at all with no prior concerns about the phenomena investigated.

2.8.1.5 'Meaning' is of essential concern to the qualitative approach.

The concern with meaning was central to this study. Multiple contextual data and in-depth interviews were employed to establish the kinds of meanings operating for both participants and observers. The concern with 'participant perspectives' (Bogdan and Biklen) in this study has been discussed at length in section 2.4.

2.9 SUMMARY

In summary the methodology is Aristotelian in its conception and has been argued in relation to the research questions asked and the issues of bias, validity, reliability, generalizability and theory building. These arguments have been advanced to support the claim that the methodology is scientifically defensible.

The 'proof of the pudding is in the eating', however, and perhaps the best defence of the methodology is the fruitfulness of the empirical study which is reported in the following chapters.

CHAPTER 3

STUDY CONTEXT AND CASE STUDY PUPIL SELECTION

3.1 SETTING

3.1.1 The School

The study took place in a predominantly open plan school within an established inner city suburb. There was a teaching staff of 16 for 430 children.

3.1.2 The Class

The class was a composite Standard Two and Three class (grades three and four) of children aged from seven to ten years. Children aged nine to ten years (Standard Three) were selected for the study because they were able to give written responses to tests and were familiar with test requirements.

The teacher selected for the study, 'T', was a senior teacher with wide experience over fourteen years in both rural and urban schools who was respected by both colleagues and parents for the quality of his teaching. T was selected because the children in his class came from a range of SES backgrounds, the children appeared to be learning from his programme, and he was prepared to permit three observers and audio-recording equipment

into his class space for the duration of the study.

The 26 children who were in T's class during the study came from a range of socio-economic backgrounds with father's occupation varying from University lecturer to freezing worker. One child was in foster care. As a senior teacher T had in his class a number of children considered by other staff members to be disturbed or disruptive and several children were judged to have learning difficulties.

3.1.3 The Buildings

The open plan block which T's class shared with two other classes (75 Standard Three and Four pupils in all) was a rectangular pre-fabricated building. There were no walls between the class spaces but the classes usually worked with their own teachers. A prefabricated room, affectionately called 'The Flea Pit', situated next to the open plan block served as a withdrawal room for activities such as painting and mime.

3.1.4 Organization

T was syndicate leader for the two other teachers (one a first year and the other with nine years experience) in the open plan block. All three teachers were male.

Although the teachers frequently planned their programmes jointly, each class programme operated independently with achievement groups interchanging teachers for language/reading lessons only. T taught the high ability group, the first year teacher taught

the average ability group and the third teacher taught the low ability group.

3.2 THE CONSERVATION UNIT

The unit studied was on conservation of the environment and was planned to be taught as three sub-topics - erosion, pollution and endangered animals. The unit was a normal part of the programme and topic selection, duration and scope were not influenced by the researcher.

The Conservation Unit was initially planned by the three teachers during three meetings attended by the researcher. The researcher took extensive written notes of the content of these meetings in order to gather information about the T's intended programme so that a pretest of the planned unit content could be constructed.

T led the meetings and kept a record of all ideas. The scope of the planning included teacher aims, content areas, resources to be used and suggested procedures. At the conclusion of the planning each teacher had a photocopy of T's summary of the planning (see Appendix B).

The teachers agreed to teach their own class groups separately using the joint planning as the basis for their programmes. Each teacher had the responsibility for a different wall display involving activities which the children worked on during individual task activity times. An arrangement was made that twice weekly the children would exchange teachers for directed silent reading lessons using stories and articles relevant to the Conservation Unit.

Although the Conservation Unit was planned for three to four school weeks, it in fact took place over seven school

weeks. On average, an hour and a quarter each day was spent on the unit, totalling almost 42 school hours. Several areas of the curriculum, including language, literature, mathematics, science, art and mime, were integrated into the unit programme along with a field trip to a local animal reserve.

Three task contexts were used: teacher-directed lessons, individual tasks and group tasks. The last two of these have not been described as 'seatwork' as is customary (Anderson, 1981; Brophy and Good, 1983) because of the considerable pupil movement to and from resources during individual and group task activity times.

A chronological overview of the Conservation Unit is attached in Appendix C.

3.3 CASE STUDY PUPIL SELECTION PROCEDURE

The three case study pupils were selected from T's class group according to five criteria: grade (Standard Three), sex (both sexes to be included in the choice), informal teacher assessment of academic ability (high, average and below average), nationally standardized Progressive Achievement Test scores (high, average and below average achievement), and finally the most demanding criterion; that the pupils selected should have no special emotional, social or physical problems.

Three weeks before the end of the first school term T was requested to discuss the 'ability' and achievement of each Standard Three child in his class. At T's request certain children were not observed as he believed that these class members might have been detrimentally affected by observer attention.

The selection process ruled out nine of the 17 standard three children in T's class, for the following reasons: repeated absences because of ill health, a speech impediment, aggression, withdrawn behaviour and attention-seeking behaviour. Of the eight remaining choices four were high achievers and only one was a consistently low achiever according to their Progressive Achievement Test Scores. Unfortunately, this child left the school the day the study began.

The final selection comprised:

> 'Gus', who was nine years and six months old at the outset of the unit. Gus was described by T as being of 'well above average ability'.
>
> 'Diane', who was nine years and three months old at the outset of the unit, was described by T as 'a good average'.
>
> 'Emily', who was 10 years old at the outset of the unit, was also described by T as 'a good average'.

T did not know which pupils had been selected.

Although it is customary in 'case study' research reporting to provide a brief description of the subjects at the outset, that procedure was considered to be inappropriate in this chapter because the results of the study provide the description of the case study pupils. School-based descriptions (e.g. test results), teacher comments, peer views, parent views, and observer and researcher interpretations are compared and contrasted with case study pupil behaviour during the unit, and with their responses to the tests and interviews.

CHAPTER 4

PROCEDURES

4.1 OBSERVATION PROCEDURE

Three observers were trained to observe continuously each of the three case study pupil's behaviour during the Conservation Unit.

A four week period prior to the introduction of the conservation unit was used to train observers and finalize the observational recording format in T's class space. During this time the researcher and the other two observers came and went frequently in both mornings and afternoons to gain experience in observing during a variety of class activities.

The observers tried to establish a 'part of the furniture' stance by avoiding any verbal or non-verbal contact with the children. Every child in the class was observed many times during the training period to help disguise the later focus on only three children.

To spread the effects of individual differences in observation techniques the three observers rotated their attention observing a different case study pupil after each hour. When Emily and Diane were absent the observers watched decoy children.

4.1.1 Observer Effects: Pupil Perceptions

Blease (1983) argued that too little importance has been attached to observer effects in classroom research and pointed out that his efforts to be 'a fly on the wall' were interpreted in unexpected ways by children. In this study questionnaires, interview questions, and informal pupil comments were used to provide data about the kind of effect the observers had on the case study pupils.

Dunkin and Biddle (1974), in discussing methodological problems in classroom research, noted that difficulties are inherent in observing human beings rather than other phenomena:

> Human beings are also observers and may adjust their activities when aware that we are observing them. (p. 58)

Their claim is well illustrated by the questionnaire response of one child in T's class:

> (I felt) Curious because sometimes they were concentrating on just one person and writing it down.

The 'part of the furniture' stance was adopted by the observers primarily to ensure that their presence would not be interpreted by the children to be directly affecting their behaviour or 'misbehaviour'. On Day 5 of the unit a new boy to the class was overheard to ask a small group of his peers whether the observer would get him into trouble if he misbehaved. The other children reassured him that the observers were not interfering. This suggests that the primary aim in adopting this stance was achieved.

The 'part of the furniture' stance was also adopted because the observers would not have been able to carry out their demanding task and interact with the children at the same time.

As 'parts of the furniture' the observers avoided eye-contact with the children - a non-verbal signal with negative connotations, avoided smiling at the children, and communicated only with the teacher. These three behaviours were uncharacteristic of the behaviours of other adult visitor-participants in T's class space.

The interviews which involved a direct one-to-one relationship between the case study pupils and the researcher were conducted only after the long-term posttest in order to eliminate interview effects on concept learning.

The questionnaire designed to elicit the children's perceptions of the observers' actions and perceptions was given to the class immediately after the unit. The results of this questionnaire show that the case study pupils were unaware of the continuous observation. None of the case study pupils believed he or she had been individually watched all the time and Gus believed he had never been individually observed. Both Diane and Emily felt that they had been individually watched some of the time. Diane explained that she knew this 'because I saw them' and Emily explained that she knew because '(the observers) were following me'. However 90% of the other pupils in T's class believed that they had been individually observed during the Conservation Unit.

The case study pupils' perceptions of observer purposes were typical of responses given by other children:

> (they came) to see how children learn
>
> Gus

> They liked to know some things about being a teacher.
>
> Diane

> (They came) to see how we work and how we learn.
>
> Emily

Emily's response may indicate that she believed we were evaluating her personally.

The children were also asked how they 'felt' about the observers' activities. Gus felt 'strange and nervous', Diane felt 'quite horebil (sic) because they were watching what we do' and Emily felt 'it was good fun'. In all, 59% of T's class reported feeling 'all right', 'okay' or generally neutral about observer presence. The other 41% of T's class reported feelings of concern such as feeling nervous or funny. Only one child, who frequently worked with Emily, gave a response which indicated that observer activity may have directly affected her work:

> (It was) hard to wrok (sic) because they look over our shourd (sic).'

Although the observers never directly leaned over a child, this child clearly felt that they had intruded in this way.

During the interviews the case study pupils said that, in spite of their reservations, they did not think that their work had been affected by the observers. However, the impersonal test situation in which they gave their initial responses (discussed above) may have

provided more accurate information.

In summary: the observers were not perceived to be 'parts of the furniture' by the children as many of the children were concerned and nervous about observer activities and such concerns may have affected class atmosphere. Less clear is whether, or to what extent, the observers' presence influenced pupil learning. However, since the case study pupils did not realize that they were being continuously watched their performance during the unit was unlikely to have been systematically affected.

4.2 RECORDING PROCEDURE

A descriptive record was made of case study pupil involvement with (or opportunity to become involved with) unit content. This record included:

4.2.1 Verbal Content

Audio recordings of all public verbal content such as teacher talk, teacher-pupil discussions, pupil responses and questions during teacher-directed lessons in both class groups and small groups.

4.2.2 Pupil Behaviours

Continuous written records of pupil behaviours during the unit. Codings were used to facilitate rapid recording and to avoid categorizing behaviours. When several behaviours occurred they were all recorded. For example, within one half minute interval Gus was described as attending to the teacher, fiddling with a rubber, acting out being a noisy aeroplane, and communicating both verbally and non-verbally with peers. Whenever possible the content of teacher-pupil conversations or pupil-pupil conversations was noted verbatim.

Vertical arrows were used to represent the length of time the behaviour persisted.

4.2.3 Resources

Photocopies or actual copies of all classroom resources used during the unit, such as relevant articles read by T or by case study pupils, wall charts, pictures, and even copies of paragraphs from reference books to which the case study pupils attended.

4.2.4 Pupil Work

Actual copies of the work the pupils produced such as unit booklets, pictures, group pictures, and stories were gathered from all pupils in T's class.

4.2.5 Task Context and Group Size

Changes in task context or group size which involved the case study pupils.

4.2.6 Other Information

Written observer notes about any event unrelated to unit content to which the case study pupils appeared to attend such as classroom interruptions for routine messages from the principal, interruptions from maintenance workers, visits from a school psychologist or mass movement through the block by other classes.

Two overhead microphones and reel taperecorders were used to record the verbal content of class lessons. This equipment was installed a week prior to the unit to help minimize the novelty effect on the children.

Each observer was equipped with 12 ten-minute observation sheets divided into forty, 15-second, interval spaces, a four colour pen, and a stop watch. The class clock served to synchronize observer records at the outset of each ten minute observation sheet and the stopwatches ensured accuracy in locating recorded pupil behaviours accurately in the time scale. Given the multiple demands on the observers, tolerances of up to 15 seconds were acceptable. Through a cross-checking procedure whereby observers noted key teacher or pupil phrases, recordings could be synchronized with transcripts of class lessons.

4.4 TEST PROCEDURES

T's written planning and the researcher's notes of the teacher planning meetings provided the basis for a 90 item test of unit content. This test was the primary instrument used to measure case study pupil learning. However the test results were supplemented: (a) by data obtained in an open recall exercise; a test designed to obtain information about unit content which occurred but had not been outlined at the planning stage, and (b) by pupil responses obtained from in-depth interviews.

The 90-item test comprised 49 multiple choice items each of which included an 'I don't know' option, three major sections requiring pupil identification of 28 concept instances (nested among 27 non-instances), and seven questions requiring pupils to supply instances. Three further items were constructed to gauge attitudinal changes during the unit. This test was sub-divided into three content areas: Erosion, Pollution, and Endangered Animals. In subsequent discussion individual test items will be referred to by the section and item number (see Appendix D).

The test was administered as a listening test to all the children in the open plan block (75 Standard Two and Three pupils) and to a Standard Four control group, both before the unit began and immediately after the unit. The children in the open plan block who were still attending the school did the test again as a long-term posttest one year later. The observers recorded observations of the case study pupils' response to the test situation.

Immediately prior to each test the children were required to record on a blank piece of paper any information about the unit topic or sub-topics (erosion, pollution and endangered animals) that they knew or could remember

learning. All children were also asked to supply additional information about their reactions to the unit and the test itself. (See section 4.5).

The administering of the test to all three classes disguised researcher focus on the case study children, contributed to the teachers' programme and provided a source of comparative data.

4.4.1 Test Effects

The administration of the test to a control group who did not study the Conservation Unit provided information about the teaching effect of the test. Because the control group was a Standard Four class (there were no other Standard Three children in the school) there may be a developmental variable in the results for the control class. An analysis of the results of the control group, who were given no formal programme, showed that each child 'learned' (short-term outcome) an average of three of the 90 test items and 'mislearned' six of the 90 test items.

The test was perceived by the pupils to have stimulated their thinking and helped their remembering:

> Oh, usually we have a test after the topic, on the topic. And that's when I really start to think about it. And I think about it for a couple of days afterwards and then I forget about it, and um start thinking on the new topic.
>
> Gus

And after clearly describing teacher-directed lessons and an individual task diagram activity, Gus added that the test also helped him remember some concepts about the hydrologic cycle:

> ...and I can remember it because we had to do it in the test. We had to draw it on the test so I think I can remember it by drawing it on the test.

Because the children in T's class were accustomed to unit posttests, test effects, such as those perceived by Gus, were part of the naturally occurring school programme. If the test did facilitate learning then this facilitative effect was operating for all items.

4.5 QUESTIONNAIRE PROCEDURES

Questionnaires were used to obtain information from all the pupils in T's class about: (a) observer effects on the pupils in T's class and the case study pupils in particular, (b) test effects and pupil attitudes towards the test, (c) pupil attitudes toward the topic of conservation and the unit sub-topics of erosion, pollution and endangered animals, (d) pupil estimations of their own learning strategies and learning success, (e) pupil preferences for task direction, and (f) peer perceptions of the case study pupils.

The questions asked were inserted in the main unit tests and an additional post unit test used to measure learning about content which had not been detailed in T's pre-unit planning. The questionnaire items are included in Appendix D.

4.5.1 Questionnaire Procedures Developed to Investigate Peer Perceptions of the Case Study Pupils

A sociometric procedure was used to obtain information about the friendship patterns and the academic leadership patterns in T's class. The data obtained from this procedure was used to interpret the quantitative findings on case study pupil interactions with peers, in relation to learning outcomes.

The questionnaire required the pupils to record the names of their 'special friends', their choice of a peer to lead a class discussion, their choice of a peer to lead a group art activity and a group writing activity, and their choice of a working partner.

4.5.2 Academic Leadership and Friendship Hierarchy in T's Class

The academic leadership and friendship hierarchy in T's class, as revealed by these questions, is shown in Table 1. The case study pupil total scores are within the three highest total scores. Gus and Emily received the highest cumulative ranking. Five pupils received higher scores than Diane. All three case study pupils were highly esteemed by their peers for leadership and friendship qualities. Because the case study pupils were selected from a list of pupils whom T approved for the study it seems that T's estimation of those pupils is in accord with the high esteem with which the case study pupils were regarded by their classmates.

An analysis of the categories in which the case study pupils received leadership votes is shown in Table 2. Emily, along with two other pupils, received four

Table 1

Academic Leadership and Friendship Hierarchy in T's Class

	Number of Votes Received			
Pupil	Leader	Partner	Friend	Total
Gavin	11	0	4	15
Emily*	10	3	2	15
Gus*	9	3	3	15
Kath	9	2	2	13
Crane	6	4	3	13
Diane*	5	2	2	9
Vera	3	2	2	7
Kim	3	2	2	7
Dani	2	2	3	7
Seth	2	2	2	6
Keith	2	1	1	4
Kane	1	1	2	4
Kiri	0	1	3	4
Hanna	0	2	2	4
Aaron	0	1	2	3
Sandy	0	0	3	3
Vivien	0	0	3	3
Sam	0	1	1	2
Colin	0	1	1	2
Sara	0	0	1	1
Jean	0	0	1	1
Harry	0	0	1	1
Mary	0	0	0	0
Jack	0	0	0	0
Dale	0	0	0	0

Note. * = Case Study Pupils

votes, the most afforded any pupil for leadership of class discussion leadership. Gus received three votes in the class discussion leadership category and Diane received only one vote in this category.

All three case study pupils received votes for leadership of a group art activity. Emily was highly esteemed for her artistic ability and received, again along with two other pupils, the highest number of votes given to any pupil in this category - three votes. Diane received two votes and Gus received one vote for group art activity leadership.

Gus received five votes, the highest, along with one other pupil, for a group writing activity. Emily received three votes and Diane received two votes in this leadership category.

In summary, Emily and Gus were perceived to be among the most competent class leaders in T's class. Emily was highly regarded for her artistic leadership and Gus was highly regarded for his leadership in written language. Gus and Emily were two of the three most frequently chosen partners in T's class. Diane was perceived to be a good leader in small group activities but was not one of the top choices.

Table 2

Analysis of Leadership Votes
Received by Case Study Pupils

	Type of Activity		
	Class Discussion	Group Art Activity	Group Writing
Pupil	Number of Votes Received		
Emily	4	3	3
Gus	3	1	5
Diane	1	2	2

4.6 INTERVIEW PROCEDURES

After the long-term posttest had been administered (one year after the Conservation Unit) interviews were conducted individually with the case study pupils and three other pupils from T's class.

Interview procedures were used for three purposes: (a) to obtain data on the children's reports of their cognitive states such as knowing and remembering, (b) to check the validity of the test responses, (c) to obtain information about the case study pupils' perceptions of their learning from both the in-class programme and out-of-class events.

The interview data was triangulated against the quantitative analyses of the observational data and against the test results. The interview procedure used in this study was similar to that described by Confrey (1981) and Piaget (1950) in that the interviews were both task-oriented and flexible. However, in order to minimize interviewer effects on pupil thinking, the interview procedures in this study differed from those employed by Piaget and Confrey in that pupil reasons and explanations were not challenged by the interviewer.

In these interviews the child was presented with a blank test form while the interviewer had the child's actual test paper. The child was asked to give his or her response to each question and explain how he or she 'knew' the answer (irrespective of whether the answer was correct or not). After the child responded the interviewer asked whether he or she knew the answer before the Conservation Unit was studied. The child was asked to explain how he or she learned each item. Additional informal interviews were conducted individually with the case study pupils in order to obtain general information. For example, how they perceived the unit in relation to other class work, how they perceived the different task contexts as working situations (teacher-directed lessons, individual tasks and group tasks), and whether they received extra help from home. The interview data was audio-taped and transcribed.

A detailed analysis of this interview data has been reported in a separate study by Nuthall and Alton-Lee (1982).

CHAPTER 5

DATA ANALYSIS PROCEDURES

5.1 OVERVIEW OF DATA ANALYSIS PROCEDURES

The data analysis procedure involved tracking each case study pupil's involvement with the content relevant to each of the 90 test items in order to establish whether there were any relationships between either the length of pupil involvement (opportunity to learn) or the kind of involvement (pupil behaviours) with specific content and subsequent pupil learning.

In this chapter the data analysis procedure is described chronologically as it was conducted. In section 5.2 the procedures used to collate all the relevant information for each basic data unit or interval are described. Section 5.3 describes the procedure for classifying each of the 15,000 30-second intervals of observational data according to the test items covered during that interval. In section 5.4 a description is given of the procedures used to construct the <u>files</u> of observational data containing the total record of pupil opportunity to interact with the content of each item for each case study pupil.

Section 5.5 contains a description of the procedures used for subdividing the data into three parallel parts and the reasons for this subdivision. Section 5.6 contains a brief discussion of the prediction procedures (which are developed more fully in Chapter 6).

In section 5.7 the quantitative analysis procedures which were carried out for time and behaviour variables are described. The consistency analyses are also discussed in section 5.7. Finally, in section 5.8 the ways in which triangulation procedures were employed in this study are described.

5.2 DATA COLLATION PROCEDURES

Details about the content with which the pupils had an opportunity to interact, the source of the content (such as teacher, book, pupil, other resources), peripheral events which occurred during the opportunity to interact (such as the movement of another class through T's class space) and observable pupil behaviours were collated for each case study pupil.

Audio-recordings of public teacher talk and teacher-pupil discussion were subdivided into half-minute sections. These sections were synchronized with the observational records for each case study pupil, and checked against observer records of key comments in the lesson.

Because the content which occurred during teacher-directed lessons was identical for all three case study pupils, all the data was collated on a single sheet. However, separate data intervals were constructed for each case study pupil for individual tasks and group tasks. In the quantitative analyses each half-minute interval for each case study pupil was analysed independently.

An example of a data interval from a teacher-directed lesson is shown in Figure 1. During this interval of a lesson taken on Day 23 of the Conservation Unit, both verbal discussion content and visual blackboard content

Figure 1.

An Example of the Classification of the Content of an Interval during Teacher Directed Task Time for Relevant Test Item Content

Test Items Endangered Animals 18-a Erosion 7 Endangered Animals 8	(The content of the interval is relevant to these three items.)

Day 23: E-A (Code number of transcript)
10.08'30" - 10.09'00"

T Why did he change? How did he change? I mean, kiwis originally had wings. Why? You know... They've got tiny, tiny little stumps now. Why?

P You see, they used to fly around in tall trees and there's a story about some...

T No, we don't want any of the myths. We want fact.

P People chopping down trees?

T No, this is a long, long, long time - thousands of years before man came. Long before man was anywhere around.

Blackboard Content : N. Z. Kiwi Kokako

Gus	Diane	Emily
LT*	LT/V `mouth'	LT
|	|	|
v	v	v

(All three pupils have an opportunity to attend to teacher-pupil discussion during this half of the interval. Diane is fiddling with her mouth.)

W	|	|
|	|	|
v	v	v

(Pupils have an opportunity to attend to teacher-pupil discussion over the second half of this interval. Gus raises hand over 15 seconds and Diane continues to fiddle with her mouth.)

Note. *Symbols approximate shorthand codes used by the observers. Explanations of those codes are provided in the brackets underneath.

comprise the content for that interval. The record of pupil behaviour associated with that content is also shown in Figure 1. As can be seen in Figure 1, all three pupils experienced the opportunity to attend to the content which occurred during this interval, although their behaviours differed. Gus raised his hand for the latter 15 seconds of the interval, Diane fiddled with her mouth throughout the 30-second interval, and Emily was passive throughout the entire opportunity to attend. None of the case study pupils communicated with peers during this interval.

An example of a data interval from an individual task time is shown in Figure 2. In this case the interval was classified for test content on the basis of the content of pupil discussion, prior conversation, and subsequent written work. An example of a data interval from group task time is shown in Figure 3. During the interval recorded in Figure 3 Gus was working in the library, in a group of three, carrying out a research assignment on the wild pig. Because this assignment was directly relevant to items concerning the wild pig and introduced animals, the interval was classified for both of these items.

5.3 INTERVAL ANALYSIS PROCEDURE

All the half-minute intervals for each case study pupil were then systematically classified according to the test item content to which the pupils were exposed. One interval could be classified as relevant to the content of a single test item, several test items occurring in the course of a rapid question-and-answer session, or remain

Figure 2.

An Example of the Classification of the Content of an Interval during Individual Task Time for Relevant Test Items

Test Items Erosion 19-5 Erosion 12 Erosion 2
Emily Day 6 2.23'30"-2.24'00" Individual Tasks
V/G* D2 'What are you doing?' | | 'I'm onto that too.' v v (Emily is fiddling, glancing around and in discussion with two other pupils during this interval.) The content of her subsequent written work, 'wind causes erosion on beaches on the sand hills and blow all the sand away', provided the evidence to classify the interval for test items involving wind as an agent of erosion and a general item on erosion.

Note. *Symbols approximate shorthand codes used by the observers. Explanations of those codes are provided in the brackets underneath.

unclassified because only content not tested occurred.

Figure 1 is an example of an interval of data recorded during a teacher-directed lesson in which content relevant to three test items occurred. The interval in Figure 1 has been classified for three items: Endangered animals 18-a (requiring the recognition of the kiwi as a native New Zealand animal), Endangered Animals 8 (concerning the endangered status of the kokako), and Erosion 7 (defining deforestation). The record of blackboard content is important for both the item on the kiwi and the item on the kokako. See Appendix D for the actual items.

5.4 ITEM FILE CONSTRUCTION

A file was constructed for each of the 90 test items for each case study pupil containing all the relevant class, group, or individual task time spent on item relevant content. For example, three copies of the interval shown in Figure 1 were required. One was attached to the file for Endangered Animals 8, one for the file for Endangered Animals 18-a, and one for the file for Erosion 7.

There was a considerable range in the size of these item files. The item file for Erosion 19-15 (concerning the river as an agent of erosion) comprised 352 intervals (2 hours 56 minutes) for Gus, 310 intervals (2 hours 35 minutes) for Diane, and 289 intervals (2 hours 24 minutes and 30 seconds) for Emily. The item file for Endangered Animals 18-x (concerning the bellbird as a native animal of New Zealand) contained no intervals at all. It was not

Figure 3.

An Example of the Classification of the Content of an Interval during Group Task Activity Time for Relevant Test Items

```
-----------------------------------------------
|Pupil: Gus                                   |
|                                             |
|Test Items                                   |
|Erosion 10                                   |
|Endangered Animals 18-k                      |
-----------------------------------------------
|Day 8              1.28'00" -1.28'30"        |
|Group Task  (Size = 3) Location: Library     |
-----------------------------------------------
|     F/  D1*   (Resource)                    |
|     |                                       |
|     .   D1   'Nature's Heritage'            |
|                                             |
|(Gus was working on a group assignment to    |
|research the wild pig as an example of an    |
|introduced animal. There were three group    |
|members: Gus, Crane and Sam. In addition     |
|to the codes above which indicate that Gus   |
|engaged in two verbal interactions with      |
|only one other group member while he was     |
|scanning the 'Nature's Heritage'             |
|reference book, the observer noted:          |
| 'Gus is using ency. & index etc. Others     |
|look on'.  At 1.29'00" Gus recorded the      |
|page numbers of the index entries he had     |
|located.)                                    |
-----------------------------------------------
```

Note. *Symbols approximate shorthand codes used by the observers. Explanations of those codes are provided in the brackets underneath.

covered during the Conservation Unit and the case study pupils were not observed to experience any opportunity to interact with content relevant to the bellbird during task time. The interviews revealed, however, that Emily had viewed museum cases of endangered birds during an out-of-school science club meeting.

Because the half-minute interval comprised the minimal unit of analysis, the calculation of total time spent on item content over-estimated the actual time spent in some cases. For example, in Figure 1 the oblique reference to the concept of deforestation took up only a few seconds of class time, but was filed as a half-minute reference.

5.5 DATA SUBDIVISION

The 90 item files were divided randomly into three parallel sets of 30 item files. Each set contained approximately the same number of items from each sub-topic of the unit (erosion, pollution, and endangered animals).

The division of item files into three representative sets of data was done in order to (a) investigate hidden researcher assumptions on a sample of data before starting the overall analysis, (b) carry out reliability checks on the internal consistency of the data, and (c) test, modify and retest hypotheses generated by the analysis of one data set against the other two data sets.

5.6 PREDICTION PROCEDURES (See Chapter 6)

The prediction procedures, involved predicting pupil test outcomes and checking these predictions against actual outcomes. The findings from the analyses of prediction errors were critical in determining the scope of the quantitative analyses. Because of the importance of prediction as a methodological tool in this study the procedures employed and the analyses are discussed fully in Chapter 6.

5.7 QUANTITATIVE ANALYSES

Quantitative analyses of the frequencies of recorded behaviours and other variables (such as time spent) were carried out for each pupil for all item files. After the quantitative analyses had been carried out the item files were grouped according to five test outcomes: (a) already known, (b) learned and remembered, (c) learned and forgotten, (d) not learned, and (e) mislearned. Thus the data for time spent on relevant content was subdivided into five different learning 'conditions'. Grand means and overall rates of behaviour frequencies were calculated for each outcome condition and compared in order to establish whether behavioural patterns were different for the time spent on content for each of the five test outcomes (that is, already known, learned and remembered, learned and forgotten, not learned, and mislearned).

5.7.1 Opportunity to Interact with Content

The term 'opportunity to interact with content' is used in preference to other terms used in the literature such as 'academic engaged time', 'content covered' and 'opportunity to learn' (Carroll, 1963; Rosenshine, 1978) because the case study pupils experienced considerable opportunity to interact with content which they already knew (as revealed by the test). Also, although the term 'time spent' is used for convenience in reporting the results, the concept of 'opportunity to interact with content' is considered to be more appropriate in this study because it avoids making the assumption that the time during which the case study pupils experienced the opportunity to interact with content was time spent actively cognizing or interacting with that content.

5.7.2 Total Time

The total opportunity to interact with the content of each item experienced by each case study pupil during the Conservation Unit was calculated in hours and minutes. Every interval during which relevant content occurred was included in this calculation.

5.7.3 Spread of Opportunity to Interact with Content

The number of discrete episodes during which each pupil experienced an opportunity to interact with content was calculated. An episode was made up of the occurrence of content during one of the three task contexts that was uninterrupted by either a change of topic or a routine class interruption. A change of task context with respect to the same content also signalled the beginning of a new episode.

By calculating the number of episodes during which specific content occurred it was possible to distinguish item content which was discussed at length on few occasions, and content which was discussed or occurred briefly on numerous occasions.

Also, the number of days over which content occurred was calculated. No account was taken of intervening days in this calculation. Thus, items for which relevant content occurred on three consecutive days were not distinguished from items for which relevant content occurred on three separate days spread over the course of the Conservation Unit.

5.7.4 Behavioural Analyses

5.7.4.1 Counting Procedures

A counting procedure had to be developed to provide summary information about behaviours which occurred for varying lengths of time. If each discrete occurrence of a behaviour had been counted the analysis would have failed to make a distinction between instances such as a momentary act of writing one word and a 20-minute period of sustained writing activity. On the other hand, if the occurrence of a behaviour any number of times within a half-minute interval had only counted as one instance then staccato patterns of behaviour, such as three or four instances of rubbing out or responding to T, within one interval would have been misrepresented by the analysis. A decision was made to count all discrete occurrences of a behaviour <u>within</u> an interval. All behaviours which persisted across intervals were counted as one instance for every interval. These decisions were found to provide the best numerical representation of the data when supplemented by qualitative data about the typical pattern of behavioural occurrence.

The counting procedure used for calculating pupil opportunity to attend (for example, to T or to a blackboard illustration) was straightforward because observer inferences about attending behaviour were eliminated. Unless the pupil was physically absent or unable to see the resource in question, each interval in which there was any opportunity to attend was counted as one instance. As the opportunity to attend typically persisted over time these frequencies were converted into minutes of opportunity to attend.

5.7.4.2 Mean Frequencies

Mean frequencies were calculated for each behaviour, each pupil, and each learning condition. This analysis provided information about the mean time spent attending to T for learned content versus the mean time spent attending to T for content which was not learned and for content which was learned and forgotten, mislearned, or already known. The set of behavioural frequencies for each pupil for time spent during each condition provided a numerical summary of the way in which the pupil spent that time and the resources to which the pupil was exposed.

The major shortcoming of mean frequency calculations is that they do not provide information about behavioural frequencies in relation to time. In order to overcome this shortcoming, calculations for the rate of occurrence of each behaviour per hour were carried out for time spent under each condition.

5.7.4.3 Behavioural Rates

The calculations of rate served to standardize each learning condition. Thus it was possible to establish not only whether more of a particular behaviour occurred for learned content, but also whether the behaviour occurred more frequently during the time spent. For example, the quantitative analysis revealed not only that more rubbing out occurred for learned content but also that rubbing out behaviour occurred at a much higher

rate during the time spent on learned content than it did during the time spent on content which was not learned.

5.7.4.4 Consistency Analyses

In order to establish whether or not a behavioural pattern was consistent within the data gathered, quantitative analyses were carried out independently for the three random sets of data. Both the consistency of mean behavioural frequencies and rates of occurrence were calculated.

An analysis of variance procedure for estimating reliability (Winer 1962, pp. 124-132) was used to assess the consistency of the relationships obtained in the three different item sets. Because the pupils did not interact with the content of some known content but spent considerable time interacting with the content of other known items, consistency analyses were not carried out for this data. Also, because mislearned items were exceptions and Gus only mislearned one item, consistency analyses were not carried out for this data.

The procedure for estimating consistency involved calculating the ratio of the variance between the three learning outcomes (learned and remembered, learned and forgotten, and not learned) to the ('error') variance between the three item sets. A criterion level of $r = 0.50$ was used to indicate a sufficient level of consistency to justify consideration of the relationship in developing the final theory.

Where inconsistent behavioural patterns were apparent further data analyses were carried out in order to identify whether the differences in the relationships evident in the three item sets, could be related to different underlying conditions.

For example, the results for items learned and remembered are very consistent across the data sets whereas the results for items learned and forgotten vary considerably and reflect both items for which little class time was spent and items for which the case study pupils spent considerable class time but lacked relevant prior experience or held strong misconceptions. Further analyses of these items according to time spent showed consistent findings for different sub-categories of items learned and forgotten.

5.8 TRIANGULATION

The triangulation of data from different sources was the final step in the analysis procedures. The procedures used were similar in principle to those outlined by Denzin (1978) as 'multiple triangulation'. Triangulation was used for four main purposes in the analysis of data: (a) the quantitative analysis of the observational data was triangulated against both the pupil test responses and the interview responses to provide information about unobservable cognitive processing associated with observable behaviour patterns, (b) teacher, pupil and observer perceptions were triangulated to establish the degree of congruence in those perceptions, (c) the beliefs of the participants and the researcher were triangulated against the empirical findings in order to confirm or disconfirm the truth of those beliefs in relation to those

findings, and (d) triangulation of every source of data available was employed to enrich the relevant contextual detail of the findings and maximize the validity of the interpretations drawn from those findings.

The actual triangulation procedures used for the first three purposes outlined above involved systematic comparisons of different data sources in order to establish congruity or incongruity. Exceptions to patterns were identified and investigated.

The triangulation of data to provide contextual detail for the findings involved identifying representative examples of pupil work, describing fully typical behavioural patterns, and using verbatim extracts from interview and observational data.

CHAPTER 6

PREDICTION PROCEDURES: EXPLORATORY DATA ANALYSES

> ...the case of the present
> difficulty is not in the
> facts but in us...
>
> (Aristotle, Metaphysics, 1:10) (McKeon, p. 712)

6.1 OVERVIEW

The prediction procedures were primarily developed to disclose covert assumptions held by the researcher, which would otherwise have operated as unconscious selection factors in the data analysis. The teacher was also asked to make predictions about case study pupil learning in order to provide information about teacher perceptions of the variables which facilitated pupil learning.

The prediction procedures employed to disclose both researcher and teacher assumptions are described in section 6.2. An analysis of the accuracy of these predictions is reported in section 6.3. In section 6.4 an analysis of the error patterns in the initial predictions of the short-term test outcomes is discussed. In section 6.5 an analysis of the error patterns in the initial predictions of the long-term test outcomes is discussed. A summary and discussion of the implications of the analyses of the initial prediction errors is given in section 6.6. In section 6.7 the results of the subsequent predictions are briefly reported. Finally, in section 6.8, the implications of the exploratory data analyses for

the data analysis procedures are outlined.

These exploratory analyses are reported in this procedural chapter because they strongly influenced the scope of the quantitative analysis procedures. Furthermore, the prediction errors reflect biases and blind spots which were common to both teacher and researcher and which are prevalent in both research and practice.

In this chapter the terms 'short-term' learning and 'learned and forgotten' are used interchangeably for the sake of convenience, as are the terms 'long-term learning' and 'learned and remembered'

6.2 PREDICTION PROCEDURES DEVELOPED TO REVEAL RESEARCHER AND TEACHER ASSUMPTIONS

The prediction procedure involved predicting the short-term and long-term test responses of the case study pupils for each test item. This required the researcher to predict whether the pupil would select a correct response, an incorrect response, or an 'I don't know' response, on each of the items in the two posttests.

The 27 possible combinations of item responses which could be predicted are shown in Figures 4, 5, and 6. Figure 4 shows the nine possible posttest response combinations given an 'I don't know' pretest response, Figure 5 shows the nine possible posttest response combinations given an incorrect pupil pretest response and Figure 6 shows the nine possible combinations given a correct pupil pretest response.

Clearly, prediction of a test response pattern involves making inferences about the meaning of those responses in terms of pupil learning. The kinds of inferences made are

Figure 4.

Possible Posttest Response Combinations Given an 'I don't know' Pretest Response and Postulated Interpretations

Response Combination			Postulated Interpretation
Pre-test	Posttest ST	Posttest LT	
DK	C	C	Learned and remembered
DK	C	I	Learned and 'forgotten' or mislearned
DK	C	DK	Learned and forgotten
DK	I	C	Mislearned during the unit
DK	I	I	Sustained mislearning from the unit
DK	I	DK	Mislearned from the unit
DK	DK	C	Learned after the unit
DK	DK	I	Mislearned after the unit
DK	DK	DK	Not learned

Note. ST= Short-term posttest
LT= Long-term posttest
DK= 'I don't know' response
C= Correct response
I= Incorrect response

Figure 5.

Possible Posttest Response Combinations Given an Incorrect Pretest Response, and Postulated Interpretations

Response Combination			Postulated Interpretation
Pre-test	Posttests ST	LT	
I	C	C	Learned and remembered
I	C	I	Learned and 'forgotten' (pro-active inhibition?)
I	C	DK	Learned and forgotten
I	I	C	Learned after the unit
I	I	I	Not learned
I	I	DK	Not learned but learned did not know, after the unit
I	DK	C	Learned s/he did not know during unit; learned after the unit
I	DK	I	Learned s/he did not know during the unit
I	DK	DK	Learned s/he did not know (sustained)

Note. ST = Short-term posttest
LT = Long-term posttest
I = Incorrect response
C = Correct response
DK = 'I don't know' response

Figure 6

Possible Posttest Response Combinations Given a Correct Pretest Response and Postulated Interpretations

Response Combination			Postulated Interpretation
Pre-test	Posttests ST	LT	
C	C	C	Already Known
C	C	I	Already known (prior knowledge unstable) mislearned after unit
C	C	DK	Already known (prior knowledge and any in unit learning unstable)
C	I	C	Mislearned during the unit
C	I	I	Sustained mislearning from the unit
C	I	DK	Mislearned during the unit
C	DK	C	Mislearned during the unit
C	DK	I	Mislearned during the unit
C	DK	DK	Mislearned during the unit

Note. ST = Short-term posttest
LT = Long-term posttest
C = Correct response
I = Incorrect response
DK = 'I don't know' response

summarized in Figures 4, 5 and 6. However, the findings of this study were used to modify, and remodify those inferential assumptions. The results revealed that sometimes identical test response combinations reflected different cognitive states. The results reported in Chapters 9 to 13 and the evidence provided for the theory advanced in Chapter 14 bring together the arguments for the modified inferences. The initial inferences served as working hypotheses. The issue of test response interpretation is also discussed in Nuthall and Alton-Lee (1982).

Four of the response patterns shown reflected learning that occurred in the interval between the short-term posttest and the long-term posttest. There was no information available about after-the-unit in-school or out-of-school learning. In spite of the difficulty of the task, the prediction of long-term outcomes was considered important because provided there had been no major related school programme, long-term learning outcomes were likely

to reflect the kind of learning that took place during the unit. The extent to which those long-term outcomes did, in fact, systematically reflect learning effects from the unit became apparent in later analyses.

In addition to the pretest responses the teacher and researcher had access to the raw data of the item files. Neither the researcher nor T had access to the actual posttest outcomes when the initial predictions were carried out.

6.3 RESULTS OF NAIVE PREDICTIONS

The first predictions involved the researcher in specifying the 30 item-response patterns for each of the three case study pupils for Prediction Set 1. The teacher predicted the item-response patterns for a subset of 15 of these items. Table 3 shows the success rate for the accuracy of the predictions made by both the researcher and teacher for the items in Prediction Set 1, matched against actual pupil test responses. The overall rate was for T, 72.2%, and for the researcher, 70.6%. If the prediction procedures had not required a distinction to be made between 'I don't know' responses and incorrect responses then the success rate would have been 76.1% overall and 80.0% for the short-term posttest.

The apparently high success rate for these predictions can be partially explained by the high number of items with correct responses on all three tests - items which were already known. This accounted for one third of the correct predictions for T and 42.2% for those of the researcher. It is not difficult to predict that if a pupil selects a correct response on a pretest then the pupil will also select the correct response on both posttests. There were, however, eight cases in which

Table 3

Percentages of Accurate Predictions for Pupil Responses to Test Items Made by the Researcher and Teacher

	Percentage of Accurate Predictions			
Predictor	Gus	Diane	Emily	Total
		Short-Term Posttest		
Researcher	76.7	66.7	70.0	71.1
Teacher	80.0	73.3	73.3	75.6
		Long-Term Posttest		
Researcher	86.7	70.0	53.3	70.0
Teacher	80.0	60.0	66.7	68.9
		Both Tests		
Researcher	81.7	68.3	61.7	70.6
Teacher	80.0	66.7	70.0	72.2

Note. T predicted case study pupil responses for 15 items and the researcher predicted case study pupil responses for all 30 items in Prediction Set 1.

pupils had correct pretest responses and this was not a correct prediction in Prediction Set One.

In order to provide a more valid index of the prediction success rates, the percentage of correct predictions was calculated in relation to those items which were not correctly answered on all three tests. This reduced the success rate of T to 58.3% and that of the researcher to 52.9%. If the distinction between 'I don't know' and

incorrect had not been required, T's success rate would have been 65.0% and the researcher's success rate would have been 62.5%.

Table 3 also shows that the prediction success rate for short-term posttest scores was about five per cent higher than the success rate for the long-term posttest. This indicates that despite the long interval between the first and second posttests, the posttest data is predictably related to pupil experience during the unit.

Also in Table 3 it can be seen that the responses of the high ability pupil, 'Gus', were more predictable than either Diane's or Emily's responses for both researcher and teacher.

In summary, the success rate of the naive predictions partially reflected the prevalence of items which were 'already known' by the case study pupils, but also reflected considerable predictability in both short-term and long-term test outcomes.

6.4 ANALYSIS OF PREDICTION ERRORS FOR THE SHORT-TERM POSTTEST OUTCOMES

The analysis of prediction errors showed that there were patterns in the errors made by the researcher and the teacher. Six kinds of prediction error were identified in the predictions of short-term outcomes (Table 4).

The most common error made by researcher and teacher was the prediction that learning would occur when it did not, in fact, occur. This over-prediction of learning outcomes accounted for over a third (38.5%) of the total prediction errors made by the researcher and one half of the prediction errors made by the teacher. This source of

Table 4

Type of Prediction Error as a Percentage of Total Errors made by the Researcher and Teacher in Initial Predictions of Short-Term Posttest Outcomes for the Case Study Pupils

	Subject of Predictions			
Predictor	Gus	Diane	Emily	Total
		(percentages)		
Predicted learning which did not occur.				
Researcher	57.1	30.0	33.3	38.5
Teacher	100.0	41.7	36.4	50.0
Failed to predict mislearning.				
Researcher	14.3	50.0	0.0	23.1
Teacher	0.0	33.3	27.3	25.0
Failed to predict learning which did occur.				
Researcher	28.6	0.0	33.3	19.2
Teacher	0.0	8.3	18.2	10.7
Incorrectly predicted mislearning.				
Researcher	0.0	10.1	0.0	3.9
Teacher	0.0	16.7	9.1	10.7
Failed to predict pupils would record an 'I don't know' posttest response given an incorrect pretest response.				
Researcher	0.0	10.0	11.1	7.7
Teacher	0.0	0.0	9.1	3.6
Incorrectly predicted pupils would record an 'I don't know' response.				
Researcher	0.0	0.0	22.2	7.7
Teacher	0.0	0.0	0.0	0.0

error accounted for all teacher prediction errors for Gus's short-term posttest responses. The researcher and T interpreted the evidence available on the pupils' opportunity to learn the item content as sufficient to ensure a correct item response when, in fact, that opportunity was insufficient. Two factors appeared to contribute to this overprediction. Firstly, the prediction that a clear explanation of content would result in pupil learning even when little time was spent on the content, was frequently incorrect. For example, Pollution Item 9 (the considerable amount of water required to produce sufficient grass to feed cows so that they can produce milk) was discussed on two occasions for only seven minutes of class time but was clearly presented with visual aids and high pupil participation in the lesson. Both the teacher and the researcher incorrectly predicted that Gus would learn from this seven minutes of class discussion. Secondly, both researcher and teacher failed to recognize the prevalence and strength of pupil misconceptions which inhibited learning. For example, Emily believed 'introduced' animals to be animals which live in bush country. This misconception was not corrected during the 73 minutes in which she experienced an opportunity to interact with the relevant content. Both researcher and teacher predicted that Emily would have learned the definition of an introduced animal because of the time spent discussing it.

The next most prevalent error for both researcher and teacher, particularly with respect to Diane's test outcomes, was the failure to predict mislearning; that is, when a pupil recorded a correct response on the

pretest but an incorrect response on the posttest. Apparently the Conservation Unit brought about unexpected mislearning of the content of seven items which the case study pupils appeared to 'know' at the outset. There are two likely explanations for this pattern. Either the correct pretest score was a meaningless guess, or the incorrect posttest score accurately reflects an inappropriate change in pupil knowledge which was caused by experience of the unit.

The frequency of mislearned patterns in the test results for the whole class provides evidence that unexpected mislearnings did occur from the Conservation Unit. For example, widespread mislearning occurred in relation to Pollution Item 2:

Pollution 2

The amount of air around our world could be described as:

(a) infinite
(b) finite
(c) nobody knows if it is infinite or not
(d) I don't know

[Note. Both 'infinite' and 'finite' were explained by T during the administration of the tests.]

One third of T's class selected the correct response 'finite' on the pretest, and 47.4% of the class selected this response on the long-term posttest. However, <u>not one child</u> selected the correct response immediately after the unit. The third of the class who selected the correct response on the pretest changed to the incorrect response of 'infinite' on the immediate posttest. During the interviews Gus explained that they had learned that plants

exchange carbon dioxide for oxygen and how he concluded that plants make the air around the earth an infinitely renewable resource. This interpretation was confirmed in informal questioning of other class members.

The third most prevalent prediction error in both researcher and teacher predictions of short-term outcomes involved the failure to predict learning which occurred in relation to items that were either not covered at all during the class time on the Conservation Unit, or were briefly mentioned with inadequate information to enable a child to record a correct response to the test. Emily learned the content of three items and Gus learned two items from out-of-class circumstances. It was impossible to predict these outcomes from in-class activities. These indicate the role of out-of-class learning for in-class achievement.

The fourth most prevalent error for both predictors involved the incorrect prediction of mislearning particularly for Diane. These predictions were made on the basis of evidence for strong misconceptions in class discussion and written work. For example, Diane explained that evaporation meant 'sinking in' in her response to T during a class discussion. The problem with predictions based on this kind of evidence is that the very exposure of a misconception frequently involved that misconception being challenged by T or other pupils. The pupil may have been in the process of changing her misconception and acquiring the relevant concept. It was difficult to determine from the data whether this process of change had occurred.

The incorrect prediction of 'I don't know' responses and the failure to predict such responses when they did occur accounted for the other prediction errors made for short-term posttest outcomes. These errors did not comprise a clear pattern.

6.5 ANALYSIS OF PREDICTION ERRORS FOR THE LONG-TERM POSTTEST OUTCOMES

Table 5 shows the pattern of prediction errors for the predictions of case study pupils'long-term test outcomes.

There were marked differences in the pattern of errors made by the researcher and the teacher for long-term posttest scores so the error types have been ordered according to the frequency of teacher error types.

The most prevalent error made by T was the overprediction of learning from the Conservation Unit. T not only failed to predict forgetting but also predicted long-term learning when no learning occurred at all.

The most prevalent researcher error was the failure to predict learning which occurred between the short-term and the long-term posttests. In order to establish whether the Conservation Unit predisposed pupils for interim learning, a post hoc analysis of the average time spent on the content of items learned after the unit was carried out. This analysis revealed that for the items in question in this prediction set, an average of 3.9 minutes was spent during the unit on the content of items which were learned in the intervening period. However, more than three times as long (that is, 14.2 minutes on average) was spent on items that were not correctly answered on either posttest. Hence, it seems that the Conservation Unit generally did not facilitate after-unit learning when immediate learning failed to occur. These prediction errors were unavoidable given that some relevant learning went on for unit content after the unit. During the interviews the case study pupils referred to concepts they had acquired in other aspects of T's programme or in class in the following year.

Table 5

Type of Prediction Error as a Percentage of Total Errors made by the Researcher and Teacher in Initial Predictions of Long-Term Posttest Outcomes for the Case Study Pupils

	Subject of Predictions			
Predictor	Gus	Diane	Emily	Total
	(percentages)			
Predicted long-term learning: no learning occurred (short- or long- term).				
Researcher	14.3	12.5	20.0	16.0
Teacher	42.9	25.0	22.2	28.6
Failed to predict forgetting				
Researcher	42.9	37.5	0.0	24.0
Teacher	28.6	16.7	22.2	21.4
Failed to predict interim learning.				
Researcher	14.3	25.0	40.0	28.0
Teacher	28.6	8.3	8.3	14.3
Failed to predict incorrect response on LT posttest after two previous correct responses.				
Researcher	0.0	0.0	30.0	12.0
Teacher	0.0	8.3	22.2	10.7
Failed to predict sustained mislearning.				
Researcher	14.3	12.5	0.0	8.0
Teacher	0.0	8.3	0.0	3.6
Predicted mislearning: pupil sustained 'I don't know' response.				
Researcher	0.0	12.5	0.0	4.0
Teacher	0.0	8.3	8.3	7.1
Failed to predict remembering.				
Researcher	14.3	0.0	10.0	8.0
Teacher	0.0	0.0	0.0	0.0

The next most prevalent source of prediction error was the inaccurate prediction of long-term learning when only short-term learning occurred (see Table 3). This pattern of error reflected (a) again the failure to judge the necessity for sufficient length of opportunity, (b) the failure to predict proactive effects of pupil misconceptions, and (c) the necessity to consider the out-of-class variable of concrete experience in contributing to long-term learning from in-class activities. For example all three pupils learned that snow was an agent of erosion but all three 'forgot' that snow was an agent of erosion one year later. Notes of peer conversations in which the pupils questioned each other about the nature of snow, and evidence of lack of experience of snow in the written work of all three pupils provided an insight into these unpredicted outcomes.

The next most prevalent prediction error involved failure to predict incorrect responses on the long-term posttest after two previous correct responses. These errors occurred predominantly with respect to Emily's test outcomes. The interviews revealed that these errors were largely explained by invalid test responses.

The fifth error pattern, the failure to predict sustained mislearning, was a minor source of prediction error but did reflect a lack of awareness about the strength of misconceptions which developed out of the class programme. The final two prediction errors did not occur frequently enough to constitute an error pattern.

6.6 IMPLICATIONS OF THE ANALYSES OF THE INITIAL PREDICTIONS

Both researcher and teacher, but particularly T, overestimated the amount of case study pupil learning that would result from the Conservation Unit. T's overestimation of pupil learning did not arise from a general view of pupil learning from the unit; he was somewhat wary of the use of a long-term posttest and pointed out that he did not expect much long-term learning to have occurred. Rather, when faced with detailed accounts of pupil opportunity to interact with specific content he made these predictions of long-term learning. A primary reason for the overestimation of pupil learning from the unit was the failure to recognize the importance of the length of opportunity to interact with content in facilitating pupil learning.

The similarity of the patterns of prediction errors in researcher and teacher predictions also reflected a common failure to understand the effects of prior concrete experience in facilitating long-term learning, the importance of misconceptions in inhibiting learning, and the likelihood of the occurrence of mislearning from the classroom programme. T appeared to be more aware than the researcher of the probability that Gus and Emily would learn from out-of-class access to content.

The prediction analysis revealed that the naive predictions showed considerable insight into the learning effected by the Conservation Unit. The analysis of errors showed that certain variables were consistently associated with the learning outcomes which were not accurately predicted.

The implication of the findings from T's predictions suggest that T showed considerable understanding of the variables which facilitated pupil learning but that further understanding of factors such as pupil misconceptions, the importance of concrete experience, and the length of pupil opportunity to interact with content would be valuable for T.

6.7 ANALYSES OF THE MODIFIED PREDICTIONS

The researcher carried out predictions of pupil learning for the other prediction sets in order to establish whether the variables of concrete experience, pupil misconceptions, and time spent were predictably associated with pupil learning outcomes. In the analysis of the initial prediction errors these variables were used as explanations for inaccurate predictions. If these variables are valid explanations for the failure to predict pupil learning then incorporating them into the prediction data would increase the prediction success rate.

Predictions were made for Prediction Set Two, Prediction Set Three, and a second time for Prediction Set One. Because there were varying numbers of known items in the different prediction sets the comparison of prediction success rates was calculated as successful predictions as a percentage of total predictions excluding all items to which the pupils responded correctly on all three tests. The comparative success rates are shown in Table 6. The success rate increased from 62.5% for the naive predictions to 73.3% for the modified predictions.

The repeated process of error analysis and prediction modification revealed that the range of opportunities to learn over a number of occasions appeared to compensate

Table 6

Prediction Success Rates (Calculated Only for those Items which were not Already Known) for Initial Predictions and Subsequent Predictions made using Information Obtained from the Analysis of the Initial Predictions.

	Test(s)		
Prediction Set	Short-Term	Long-Term	Overall
	(Percentages)		
PS1 (Initial)	63.5	61.5	62.5
PS2	69.8	73.6	71.7
PS3	81.8	54.5	68.2
PS1	68.9	77.8	73.3

for less time spent. Also, if a pupil had little time to learn but that time included both teacher-directed opportunity and task opportunity then learning could be successfully predicted. For example, although Emily only had 27.5 minutes of opportunity to learn that fire is an agent of erosion, this concept, which she did in fact learn and remember, occurred on nine occasions over seven days in both teacher-directed lessons and individual task contexts.

In spite of these insights into the prediction errors about a third of the item responses were unpredictable. An analysis of the error types in the later predictions is shown in Table 7. The analysis of error types has been carried out across the three sets of modified predictions because the same types of error occurred in each case and there appeared to be a ceiling on the success rate of the predictions at this stage.

Table 7

Prediction Error Types in Researcher Predictions of Pupil Learning for Items In Prediction Sets Two and Three and Modified Predictions for Prediction Set One

Prediction Error Type	Percentage of Total Errors
Predicted learning and/or remembering when none occurred.	47.4
Prediction errors associated with pupil mislearning or misconceptions.	26.3
Failure to predict learning or remembering which did occur.	19.3
Failure to predict learning which occurred after the unit.	7.0

As can be seen in Table 7 almost half of the prediction errors involved prediction of learning and/or remembering which did not occur. A further analysis of the errors in this category revealed that 36.1% of those errors involved prediction of short-term learning which did not occur, 36.1% involved predictions of remembering which did not occur, and 27.1% involved predictions of both short-term learning and remembering when no learning occurred at all. Thus, there was no particular type of learning which consistently was being predicted incorrectly. In effect, it was very difficult to identify variables which were inhibiting both learning and remembering.

Some of these errors (predicting learning which did not occur) may be attributable to the failure to identify pupil misconceptions; that is, misconceptions for which there was no recorded evidence. However, as can be seen in Table 7, a further 26.3% of the errors made after the initial predictions can be directly explained by difficulties in predicting the existence of, and persistence of, pupil misconceptions. Although, a number of accurate predictions were made that mislearning would occur, some cases of mislearning which did occur were consistently undetected. For example, in the predictions for Prediction Set Two, Emily's mislearning that the bat is not a native New Zealand animal was correctly predicted. However, Diane's mislearning that smog is pollution was not predicted. The data was inadequate to systematically reveal the presence of pupil misconceptions which were extant during the unit.

The failure to predict learning which occurred after the unit and between the two tests was a difficulty which has been discussed earlier in this chapter. Another unresolvable prediction difficulty was the problem of out-of-school learning which accounted for at least half of the errors in the failure to predict learning category.

Probably about a third of the prediction errors are not entirely explained by the factors discussed above. The ceiling on the success rate of the predictions shows the lack of predictive value in the kinds of pupil behaviours that the researcher inferred were either facilitating learning or inhibiting learning. This was especially true in cases when less class time was spent on relevant content.

6.8 THE IMPLICATIONS OF THE PREDICTION ERROR ANALYSES FOR THE DATA ANALYSES PROCEDURES

6.8.1 Predictive Power of the Time Spent Variable

Pupil opportunity to interact with content (that is, the length of the item file) was found to be the best single predictor of pupil learning. Hence, comprehensive analyses of 'time spent' were carried out. Further, the kinds of variables which appeared to compensate for length of opportunity (number of opportunities and opportunities to interact with content in both teacher-directed and pupil task contexts) were analyzed. These analyses are reported in Chapter 8.

6.8.2 Concrete Experience: A Critical Pre-Condition for Long-Term Learning

Concrete 'here and now' experience of concepts was revealed to be a critical precondition of long-term pupil learning that was systematically predictive of the exceptions to the 'time spent' variable. This relationship was discovered from an analysis of errors in both the teacher and researcher predictions. Hence, information had to be gathered about the environmental experiences of the case study pupils. This data was attached to each item file. An analysis of pupil experience in relation to pupil learning is reported in Chapter 12.

6.8.3 Importance of Pupil Misconceptions in Inhibiting Learning

Both the teacher and researcher failed to identify the strength, persistence and pro-active effects of pupil misconceptions about the concepts studied. Hence, pupil pretest responses were reanalyzed as was the description of total in-class opportunity to interact with content in order to identify all evidence of pupil misconceptions about the tested concepts. Pupil misconceptions were found to explain cases for which 'forgetting' occurred in spite of time spent. Examples of pupil misconceptions are examined in more depth in Chapter 12.

6.8.4 Attitudinal Changes: Exceptions to the 'Time Spent' Pattern

The items which were used to measure pupil attitudinal changes were found to be exceptions to the 'time spent' finding. The three attitudinal items were separated from the remaining item files and a discussion of these findings is reported in Chapter 12.

6.8.5 Unexpected Learning Patterns

The amount of time spent by the pupils on content which they already knew (as measured in the pretest) was considerable and surprising to both the teacher and researcher. Qualitative analyses were carried out to explore the function and consequences of the time spent on 'known' content. The amount of mislearning that occurred was also an unexpected finding. Hence, in addition to the short-term learning, long-term learning, and failure to learn categories, already known and mislearning categories were employed in the subdivision of data into categories for analysis. These unexpected patterns are also discussed further in Chapter 12.

6.8.6 Inadequacy of Researcher and Teacher Assumptions in Identifying Pupil Behaviour Patterns Predictive of Learning

Pupil behaviours which were related to pupil learning were, at best, weakly and unsystematically predicted by the researcher and teacher. Hence, 'common sense' criteria for the selection of behavioural data to be

counted were abandoned. A criterion of feasibility was employed instead; that is, if a behaviour occurred frequently enough to be counted it was counted.

6.9 SUMMARY

The prediction procedures were used as tools to carry out exploratory data analyses. They were used to identify the kinds of implicit data selection criteria that could limit the analyses of the data gathered. These procedures were not intended to supplant those analyses. By their nature such prediction procedures are imprecise. Hence, the variables identified by the prediction procedures as facilitative or inhibitive of pupil learning were identified as contenders for analysis, not results of the study.

The prediction procedures performed a further valuable service. By highlighting those variables which were not adequately taken into account by the researcher and teacher the prediction procedures served to identify the kinds of findings from this kind of investigation which might be of most value to the practitioner. Insights which confirm the wisdom of the practitioner are of value. Of equal or even greater potential value are those insights about pupil learning which are not part of the working 'knowledge' of the practitioner.

CHAPTER 7

OVERVIEW OF RESULTS AND ANALYSIS OF CASE STUDY PUPIL LEARNING FROM THE CONSERVATION UNIT

7.1 OVERVIEW OF RESULTS

In this chapter the general pattern of learning by the case study pupils from the Conservation Unit is outlined. Pupil, teacher and observer perceptions of how much the case study pupils learned are discussed and the unit test results of all the pupils in T's class are compared with the case study pupils' learning. Case study pupil learning from the unit is compared with their performance on nationally standardized Progressive Achievement Tests.

An analysis of item outcomes which were the same for each of the case study pupils is provided in order to establish the extent to which the pupils learned the same or different content.

In Chapter 8 an analysis of the positive relationship between time spent (opportunity to interact with specific content) and pupil learning is reported. The amount of time spent, the number of discrete opportunities to interact with content within the total time spent, and the number of days upon which particular content occurred are all examined in relation to pupil learning. An analysis of the relationship between pupil opportunity to interact with content in teacher-directed lessons, individual task contexts, group task contexts and combinations of the three task contexts is also reported in Chapter 8. In Chapters 9, 10, and 11 relationships between pupil

behaviour patterns and pupil learning for each of the three task contexts are examined separately.

In Chapter 12 exceptions to the positive relationship between time spent and pupil learning are examined. Cases where content was learned when pupils had little or no opportunity to learn it during class are discussed. Cases where there was considerable pupil opportunity to interact with content but only short-term learning outcomes or no learning occurred are also examined. Also, in Chapter 12 the surprising pattern of attitudinal changes for both case study pupils and other pupils in the open plan block is discussed.

In Chapter 13 a summary of results is provided. A theory of pupil learning is advanced in Chapter 14, and the implications of this study are briefly discussed in Chapter 15.

7.2 PUPIL, TEACHER, AND OBSERVER PERCEPTIONS OF CASE STUDY PUPIL LEARNING FROM THE CONSERVATION UNIT

7.2.1 Gus

Gus reported that the Conservation Unit was 'quite good in some ways'. In the interview, one year after the unit Gus said that he did not consider the Conservation Unit as special but that he 'enjoyed it as part of the programme'. He considered studying endangered animals most interesting of all unit content because he 'learnt of some animals (he) didn't know of' and he would have liked to have learned more about them. Gus reported being pleased with the work he did 'because (he) got a fair bit done' and displeased with his work 'because it

was pretty untidy'.

T commented on Gus's unit booklet: 'good coverage, deep thought, very untidy -comprehensive book'. It is interesting to note the congruence between Gus's self-assessment and T's assessment because neither had access to the other's remarks when those comments were made.

On Day 3 the ex-teacher observer remarked that she had a 'feeling this one will learn most even though he is the most difficult to observe'. The reservation expressed about observational difficulty concerned the frequency of Gus's behaviour changes. All three observers believed that Gus would learn a great deal from the unit. However, he was also perceived to some degree by all observers to have 'fooled about'. The non-teacher observer believed he had 'wasted time'.

In summary, Gus perceived learning to be an important component of his achievement as well as productivity ('got a fair bit done') and was pleased with his overall achievement but displeased with the quality of his presentation. Gus's behaviour was not perceived to be predominantly on-task in a traditional sense but both T and observers had the impression that he had learned a great deal from the unit.

7.2.2 Diane

Diane 'felt good (about the Conservation Unit) because (she) learnt a lot'. She perceived the most interesting thing that she learned to be 'that there are so many endangered animals'. She would have liked to have learned more about deforestation. Diane was pleased with the work she did 'because (she) showed

(herself) how much (she) learnt'.

T commented that Diane 'worked well, neat - very good book' but pointed out that she was hampered by her 'lack of imagination'. A frequent interaction pattern between T and Diane involved Diane taking her written or diagramatic work to T for his approval. Rarely was his approval forthcoming and these interactions involved T explaining, at length, requisite corrections and changes.

All three observers commented on the high level of (perceived) 'on-task' behaviour of Diane who worked quietly for long periods with considerable persistence and few interactions with peers.

Diane was pleased with her own learning from the unit. Both T and observers commented on her excellent work habits and attempts to achieve neat work. However, the observers noted her frustration in failing to meet T's standard.

7.2.3 Emily

Emily reported the Conservation Unit to be 'good fun'. A year later she said that it was 'one of the interesting things we did'; she did not consider it to be special. She considered pollution to be the most interesting thing studied and she would have liked to have learned more about pollution. Emily reported being pleased with the work she did because it was also 'good fun'.

T commented of Emily's unit booklet: 'very neat, well presented, careful thought - very good book'. T showed frequent approval of Emily's work and generally

initiated interactions with Emily who appeared to wait for T to arrive.

The observers perceived Emily to be generally passive or 'switched off' during teacher-directed lessons. Emily was perceived to be 'bossy' during activity times and because of the considerable time she spent interacting with her peers, particularly to discuss the ownership, lending rights and qualities of felt-tipped pens, she was perceived to have learned relatively little by all three observers.

7.3 CLASS TEST RESULTS AS A CONTEXT WITHIN WHICH TO INTERPRET THE CASE STUDY PUPILS' TEST RESULTS

Table 8 contains individual test results for the 19 members of T's class who were present at all three tests. Only 75 of the 90 items were included in the final analyses. In addition to the four attitudinal items and seven open-ended question-type items, four items which overlapped substantially with the content of other items were excluded.

The open-ended items were omitted because the case study pupils had omitted responses on these items and it was difficult to judge the probable short-term outcomes from the interviews because of the time lapse. The overlapping items were eliminated because repetition of item files would have biased the result patterns. The reliability of the results is increased by maximizing the difference between the content of the items. A separate analysis of the attitudinal items is provided in Chapter 12.

Case study pupil test scores were corrected for information gained in the interviews. Pupils were asked to recall and give reasons for their test responses.

Where it was clear that the actual test response did not reflect the view expressed during the interview and the pupil appeared certain about the interview response the test scores were altered. For example, Gus explained that he really did understand that people caused pollution in answer to Pollution Item 1 but during the long-term posttest he had momentarily failed to realize that the erosion sub-test section had finished and he had misread 'erosion' for 'pollution'. However, both the uncorrected and corrected scores are given in Table 8 in order to make a direct comparison between case study pupil test scores and the uncorrected scores of other class members (who were not interviewed).

In Table 9 pupils have been ranked on the basis of total scores on known and learned items as measured by the short-term posttest and also on the percentage of items correct that were not already known. This calculation was carried out to differentiate between pupils who had little prior knowledge but learned a great deal and pupils who had little prior knowledge and learned relatively little.

Overall Gus was the third highest achieving pupil in T's class with the fifth highest prior knowledge score. Diane scored among the three lowest achievers and had the fifth lowest prior knowledge score. Diane had the lowest relative gain from the Conservation Unit as measured by the percentage of items learned out of total unknown items. Emily was the sixth lowest achiever from the unit but was slightly above average with respect to the percentage of unknown items that she learned. Emily had the third lowest prior knowledge score.

Thus Gus's achievement in relation to the unit, as measured by the test based on teacher planning, was well above average. This was congruent with the pre-unit assessment of general ability made by T.

Table 8

Case Study Pupil Test Scores and (Interview Adjusted Test Scores) in relation to Test Outcomes for T's Class Ordered for Prior Knowledge Scores

	Item Outcome				
Pupil	Already Known	Learned LT	Learned ST	Not Learned	Mislearned
Keith	53	9	3	7	3
Hanna	46	11	7	10	1
Kath	45	11	5	10	4
Crane	43	15	2	9	6
*Gus	42(43)	14(15)	8(7)	10(9)	1(1)
Gavin	42	9	7	12	5
Kim	40	15	7	9	4
Cane	37	22	6	5	5
Sara	32	15	9	10	9
Aaron	31	15	13	12	4
Vera	31	12	8	11	13
Colin	29	25	7	11	3
Seth	29	16	14	7	9
Sam	29	16	9	17	4
*Diane	29(29)	12(14)	6(4)	18(19)	10(9)
Kiri	27	22	10	8	8
*Emily	26(28)	15(20)	14(6)	13(13)	7(8)
Dani	19	15	10	23	8
Mary	14	16	15	21	9
Mean**	34	15	8	12	6

Notes
Only 19 of the 25 members of T's class were present for the pretest and both the short term and long term posttests.
**Mean scores rounded to whole numbers.

Diane's achievement was well below average in contrast with T's pre-unit assessment of her general ability as a 'good average'. Diane's low level of learning from the unit also contrasted with observer perceptions.

Emily's achievement was average when measured by the percentage of unknown items that she learned but was below average when measured by her total score. Her achievement in relation to the unit was lower than T's general assessment of her ability would predict but higher than the observers would have predicted.

The first point to be made in considering the case study pupil test scores is that the class learned a substantial proportion of the content included in the unit as measured by the test. The mean prior knowledge score for the class was 34 out of the 75 items in the final test analysis (45% of the items). A further 30% were learned, on average, by class members and two thirds of this learning was long-term learning. Twelve items (16%) were not learned, on average, and 8% of the items were mislearned. (See Table 8 for raw scores).

7.4 CASE STUDY PUPIL LEARNING IN RELATION TO STANDARDIZED ACHIEVEMENT SCORES

Because class achievement was generally high (for the 19 class members who were present for all three tests) and because of the age differences between the case study pupils, case study pupil achievement from the Conservation

Table 9

Pupils Ranked by Total Correct on Short-Term Posttest and by Percentage of Unknown Items Which were Learned (Short- and Long-Term)

Ranking	ST Posttest Total (Raw Scores)		Percentage of Unknown Items Learned	
	Pupil	Total (Out of 75)	Pupil	Percentage
1	Keith	65	Cane	73.7
2	Cane	65	Colin	69.6
3	*Gus	64	*Gus	66.7
4	Hanna	64	Kiri	66.7
5	Kim	62	Seth	65.2
6	Colin	61	Aaron	63.6
7	Kath	61	Kim	62.9
8	Aaron	59	Hanna	62.1
9	Seth	59	*Emily	59.2
10	Kiri	59	Sara	55.8
11	Gavin	58	Keith	54.5
12	Crane	57	Sam	54.4
13	Sara	56	Kath	53.3
14	*Emily	55	Crane	53.1
15	Sam	54	Mary	50.8
16	Vera	51	Gavin	48.5
17	*Diane	47	Vera	45.5
18	Mary	45	Dani	44.6
19	Dani	44	*Diane	39.1

Unit is compared with their achievement on nationally standardized achievement tests to provide a wider perspective on their achievement from the unit.

Table 10 shows case study pupil percentile scores on nationally standardized Progressive Achievement Tests administered three months before, and eight months after the Conservation Unit. Gus's performance on both testing occasions was consistently high and congruent with his high achievement in relation to the unit. Both Diane and Emily's test scores show considerable variability within and between testing occasions. Diane's reading and mathematics scores were average to above on the first testing occasion but her study skills were well below average. All her scores were above average in February of the following year. Emily's test scores were below average except for her mathematics, before the unit. The following February her scores varied just as dramatically making an estimation of her general achievement very difficult.

The study skills tests results were most congruent with the case study pupil performance in the Conservation Unit; Gus's results were well above average, Emily's results only slightly below average, and Diane's results well below average. Because these study skills tests included skills such as diagram and chart interpretation and use of references which were skills required for many of the tasks set during the Conservation Unit these results may indicate a variable which influenced the different outcomes from the unit of the case study pupils.

Table 10

Progressive Achievement Test Results for the Case Study Pupils for 1979 and 1980

Test	Pupils		
	Gus	Diane	Emily
	Percentile Scores		
February of the Year of the Study			
Reading Vocabulary	95	63	36
Reading Comprehension	-	-	32
Listening Comprehension	93	36	14
Mathematics	91	51	54
Study Skills 1	77	32	49
Study Skills 2	88	34	44
February of the Year Following the Study			
Reading Vocabulary	79	78	33
Reading Comprehension	98	82	60
Listening Comprehension	93	67	36
Mathematics	79	60	75

The variation between P.A.T. scores for Diane and Emily over time and between subject areas highlights the difficulties in making general assessments of pupil 'ability' or 'achievement' for individual pupils.

7.5 THE IMPLICATIONS OF THE CONSERVATION UNIT CLASS TEST RESULTS FOR INTERPRETING CASE STUDY PUPIL RESULTS

Three patterns in the class test results have important implications for the interpretation of the results: (a) the high level of prior knowledge, (b) the prevalence of mislearning patterns, and (c) the pattern of both short-term and long-term learning outcomes.

Each of the pupils in the class knew, on average, about half of the items, although the known items were mostly different for different pupils (see 7.6). The fact that pupils in T's class appeared previously to know so much of the taught content raised a number of questions about the function of time spent on content already known by each of the pupils. For example, were the pupils bored by further opportunity to interact with this content? Did they choose to avoid this known content during individual tasks? Pretesting is not a common procedure in primary classrooms so teachers must be frequently unaware of the scope of pupil prior knowledge. Research in this field has focused on pupil gain scores, and little is known about the function of class time spent on known content. For this reason, the time spent by the case study pupils on apparently known content has also been analyzed.

The prevalence of mislearning patterns in T's class test results also has implications for the interpretation of case study pupil mislearning. It can be seen in Table 8 that the numbers of items mislearned were generally high for all class members. Gus's very low score of one item mislearned was atypical and shared by only one other pupil who had a higher prior knowledge score. Mislearned scores seemed to be related to prior knowledge scores. Generally the higher the number of items already known, the lower the number of items mislearned. The mean mislearned score for the five pupils with the highest prior knowledge

scores was three items but the mean mislearned score for the five pupils with the lowest prior knowledge scores was 8.4. Diane's and Emily's mislearning scores were high (see Table 8). Mislearning was not an atypical occurrence; especially for the low achievers. And for this reason the class time during which the case study pupils had an opportunity to interact with mislearned content has also been analyzed.

The third pattern apparent in the class test results is the finding that all pupils learned and 'remembered' the content of some items and learned and 'forgot' the content of other items.

On average twice as many items were learned and remembered as were learned and forgotten. Although there was variablility on the proportion of long-term to short-term learning all pupils remembered more than they 'forgot'. This finding raised the question of whether there were systematic differences between pupil opportunity to interact with content which was learned and remembered and pupil opportunity to interact with content which was learned and 'forgotten'. This question has not been systematically investigated in the field of classroom research. 'Short-term learning' is a term that is frequently used to denote all learning that is apparent in a short-term posttest. In this study short-term learning means learning that was not sustained one year after the unit. There is an important consequence for children's ongoing school achievement in the extent to which classroom learning is retained. Thus, the content of items learned and remembered and the content of items learned and forgotten were analyzed separately.

Another question raised by the class test results is the extent to which different pupils learned and remembered or learned and forgot the <u>same</u> items.

If the case study pupils had the same outcomes for the same content the results would suggest a strong teaching or content effect. If individual item outcomes were different for each case study pupil then the results would suggest individual pupil learning differences if only in the use they made of individual task opportunity. This question is examined in the following section.

7.6 PREVALENCE OF ITEM OUTCOMES COMMON TO CASE STUDY PUPILS

The analysis in Table 11 shows that there were 14 out of 75 items that were known before the unit by all three pupils. These constitute what might be termed the core knowledge of the unit held by the case study pupils. The two items in the erosion sub-test known by all three pupils involved identifying a definition of environment, and classifying rain as an agent of erosion. The eight known items in the pollution sub-test involved identifying people as the prime cause of pollution; classifying broken bottles, litter and smoke from cigarettes, a forest fire, and a car exhaust as forms of pollution; knowledge about the damaging effect of noise on hearing, and the existence of water underneath the school grounds. On average these 14 items were already known by 80.5% of T's class.

Almost half of the learned and remembered outcomes were unique to one pupil. That is, half of those learned and remembered by one pupil were not learned and remembered by the other two pupils (see Table 11).

This finding is critical because it means that the strong patterns of relationships between pupil behaviours and learning outcomes reported in Chapters 8 to 13 occurred across pupil involvement with different content. Thus,

Table 11

Items with Learning Outcomes Common to Case Study Pupils

Learning Outcome	Item Outcome: Common (3 Pupils)	Common (2 Pupils)	Different Outcomes	Total Items
Already Known	14	19	20	100
Learned & Remembered	3	8	24	49
Learned & Forgotten	1	3	8	17
Not Learned	2	9	17	41
Mislearned	0	1	16	18
Total	20 (60 items)	40 (80 items)	85	225

the strong similarities in the pupil behaviour patterns which are related to learning and remembering cannot be attributed to a content effect, or a general teacher behaviour effect, because each pupil generally learned different content from that learned by the other case study pupils during the course of the same class activities.

The three items which were learned and remembered by all three pupils required the pupils to identify that fires and glaciers are agents of erosion and that opossums damage the native New Zealand forests. On average 26.3% of T's class already knew these three items and just over half the class (50.9%) learned and remembered the items.

Over half the learned and forgotten outcomes were unique to one pupil. The single item learned and forgotten by all three pupils involved identifying snow as an agent of erosion. The pattern of class results for this item is very similar to the average class pattern for items learned and remembered. Again 26.3% of T's class already knew the item and 47.4% of the children learned and forgot the item.

Only two items were not learned by all three pupils. These items involved classifying the sun as an agent of erosion and the bat as a native New Zealand animal. Not a single child knew that the bat is native to New Zealand and only two children already knew that the sun is an agent of erosion. Almost three quarter's of T's class (71.1%) failed to learn these two items. Three pupils went into the unit believing that the sun is an agent of erosion but mislearned this content during the unit.

In summary, about a quarter of all item outcomes were common to all three pupils. Nearly 40% of the test outcomes were unique to only one of the three case study pupils. Thus the findings show that there were more differences than similarities (in relation to specific item content) in pupil learning patterns. These differences must be partly related to the differences in prior pupil knowledge. The children were generally learning different items but there were some test items with identical outcomes for not only the case study pupils but also a large number of other children in T's class. This finding suggests that there may have been critical lessons which had a strong impact on class learning. It also suggests that apart from that minority of items with shared outcomes pupil experience of content or response to that experience may have varied considerably.

7.7 SUMMARY

Considerable learning (both short-term and long-term) did occur for all three case study pupils. Although the various assessments that Gus would achieve at an above average level were congruent with his test and interview outcomes the assessments of Diane and Emily showed considerable variability. Diane's test results relative to the rest of T's class indicated that her achievement was well below average. Emily's gain from the unit was slightly above average.

The class test scores indicated that between one third and one half of the tested content was known by the pupils at the outset of the unit and that mislearning occurred for all pupils, but particularly for those with little prior knowledge.

The analysis of common item outcomes revealed that the case study pupils had predominantly learned different content. Thus the quantitative analyses of reported in the following chapters are not bound to specific content.

CHAPTER 8

OPPORTUNITY TO INTERACT WITH CONTENT IN RELATION TO LEARNING OUTCOMES

8.1 OVERVIEW

In this chapter the relationship between pupil opportunity to interact with content or 'time spent' and case study pupil learning is reported. In section 8.2 the parameters of 'opportunity to interact with content' in this study are clarified in relation to definitions adopted in other recent research in this field. In section 8.3 the relationship between total minutes of opportunity to interact with content and pupil learning is examined. In section 8.4 the number of discrete episodes and the number of days during which case study pupils had an opportunity to interact with specific content are examined in relation to pupil learning. In section 8.5 the relationship between pupil learning and pupil opportunity to interact with specific content during different task contexts is explored. The extent to which learning was related to opportunity to interact with content in all three task contexts (teacher-directed, individual tasks and group tasks), two task contexts, or only one task context is examined. In section 8.6 the amount of time the case study pupils spent in the three task contexts is analyzed in relation to pupil learning. The findings are summarized in section 8.7.

8.2 DEFINITION OF PUPIL OPPORTUNITY TO INTERACT WITH CONTENT

The 'time spent' or 'opportunity to interact with content' variable which has been analyzed in this study is different from the 'time spent' variable in other investigations. Rosenshine and Berliner (1978) pointed out that ever since Carroll (1963) drew attention to the importance of pupil 'opportunity to learn' this variable has been studied in many ways. These include: inspection of text books, teacher perceptions of student opportunity to learn, coding content of short presentations, counting numbers of words taught, mathematical problems covered, workbook levels reached and workbook pages covered.

Brophy and Good (1983), in summarising research findings about 'opportunity to learn/content covered' referred broadly to investigations of pages of curriculum covered, percentage of test items taught through lecture or recitation, and length of school day and year.

In the present study the 'opportunity to interact with content' was a precise measure of both the content covered and the time spent on that content. All case study pupil opportunities to interact with specific content in all task contexts in both formal and informal situations were included and the total time taken up by all these opportunities was calculated. For example, a pupil experienced an opportunity to interact with content relevant to a specific test item when: T led class discussion about that content, a book he or she was reading included reference to that content, a conversation with another pupil included reference to that content, or a set task involved that content. The term 'occurred' (as in 'content occurred during a teacher-directed lesson') is used because it establishes when a pupil had an opportunity to interact with content without carrying any

Table 12

Mean Length and Spread of Pupil Opportunity to Interact with Content in Relation to Learning: Means Calculated for All 75 Test Items

Pupils	Minutes	Episodes	Days
	Items Already Known		
Gus	43.1	11.2	5.7
Diane	44.6	11.5	5.3
Emily	40.8	10.5	5.0
Mean	42.9	11.1	5.4
	Items Learned and Remembered		
Gus	89.4	17.5	7.0
Diane	81.6	16.9	7.4
Emily	62.3	13.0	6.0
Mean	76.1	15.5	6.7
	Items Learned and Forgotten		
Gus	58.6	13.7	5.6
Diane	20.1	10.0	4.8
Emily	46.5	12.3	5.7
Mean	45.3	12.4	5.4
	Items Not Learned		
Gus	5.4	3.0	2.1
Diane	18.8	5.1	3.2
Emily	13.6	5.9	3.6
Mean	14.2	4.9	3.1
	Items Mislearned		
Gus	1.0	1.0	1.0
Diane	40.1	8.4	4.0
Emily	14.8	6.5	3.3
Mean	26.7	7.2	3.5

Table 13

Mean Length and Spread of Pupil Opportunity to Interact with Content in Relation to Learning: Means Calculated Only for Items Which Occurred During the Conservation Unit (95.1% of All Items)

Pupils	Minutes	Episodes	Days
	Items Already Known		
Gus	44.2	11.5	5.8
Diane	46.1	11.9	5.5
Emily	40.8	10.5	5.0
Mean	43.8	11.3	5.5
	Items Learned and Remembered		
Gus	89.4	17.5	7.0
Diane	81.6	16.9	7.4
Emily	65.6	13.7	6.3
Mean	77.7	15.8	6.8
	Items Learned and Forgotten		
Gus	58.6	13.7	5.6
Diane	20.1	10.0	4.8
Emily	55.8	14.8	6.8
Mean	48.1	13.1	5.8
	Items Not Learned		
Gus	6.9	3.9	2.7
Diane	19.9	5.4	3.4
Emily	14.8	6.3	3.9
Mean	15.8	5.4	3.4
	Items Mislearned		
Gus	1.0	1.0	1.0
Diane	51.6	10.9	7.9
Emily	16.9	7.4	3.7
Mean	32.0	8.6	4.2

Table 14

Reliability Coefficients for Time Spent

Variable	Overall Mean	Gus Mean	Diane Mean	Emily Mean
Total Time	0.72	0.67	0.96	0.77
Teacher-directed Lesson	0.69	0.73	0.78	0.59
Individual Tasks	0.77	0.75	0.99	0.56
Group Tasks	0.23	0.00	0.68	0.00
Total Episodes	0.88	0.86	0.77	0.73
Teacher-directed Episodes	0.87	0.90	0.67	0.39
Individual Episodes	0.86	0.79	0.89	0.49
Group Episodes	0.34	0.18	0.00	0.00
Days	0.85	0.89	0.84	0.00

inference about actual pupil interaction with that content.

As was discussed in Chapter 4, the averages calculated for pupil time spent are often slight overestimations because content which occurred for only part of a half minute interval was counted for a whole half minute.

In this discussion the terms 'time spent' and 'opportunity to learn' are used for convenience but denote 'opportunity to interact with content'.

8.3 LENGTH OF PUPIL OPPORTUNITY TO INTERACT WITH CONTENT

Length of pupil opportunity to interact with content was strongly and consistently ($r = 0.72$) related to learning for all three case study pupils (see Table 12, and Figures 5, and 7). They had the longest opportunity to interact with the content of items learned and remembered (about an hour and a quarter, on average, per item), the second longest opportunity to interact with the content of items learned and forgotten, (about three quarters of an hour, on average, per item), and the least opportunity (about quarter of an hour, on average, per item) for items not learned. Pupil opportunity to interact with the content of items already known was three quarters of an hour, the same time as with content learned and forgotten. The relationship between time spent and learning was more consistent for Diane ($r = 0.96$) than for Gus ($r = 0.67$) or Emily ($r = 0.77$). The interviews revealed that unlike Gus and Emily, Diane had few opportunities to learn tested content outside of the class programme. This explains the very consistent relationship between Diane's learning and her in-class opportunity to learn.

Figure 7

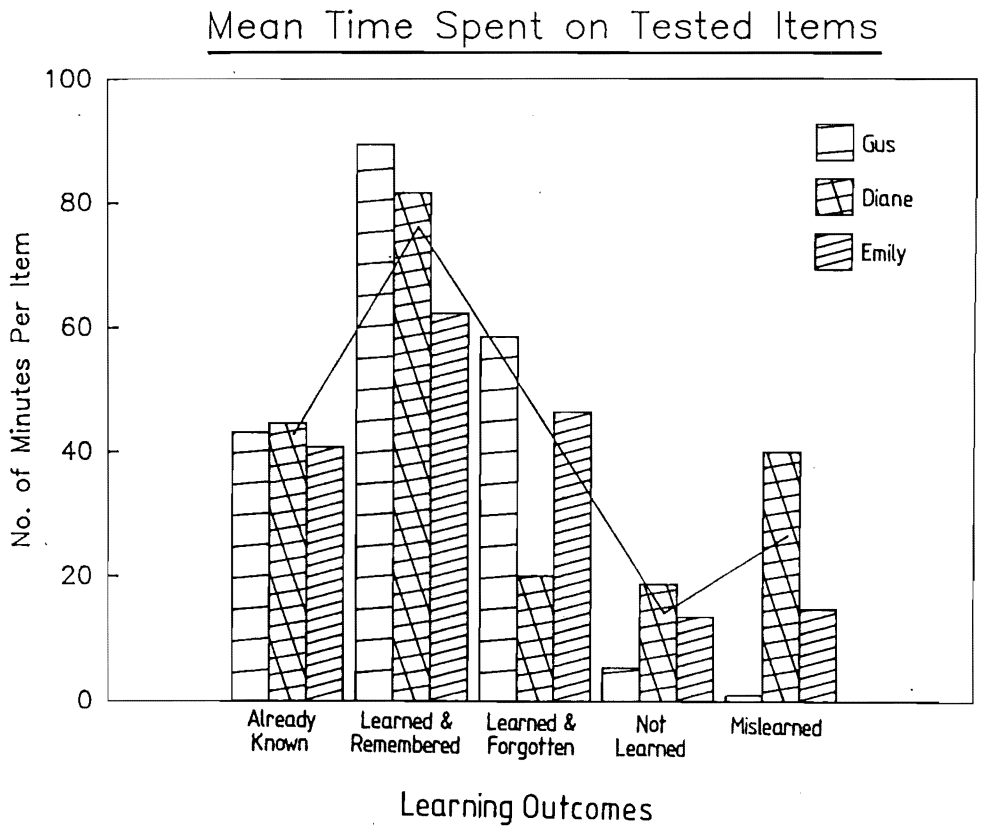


Figure 8

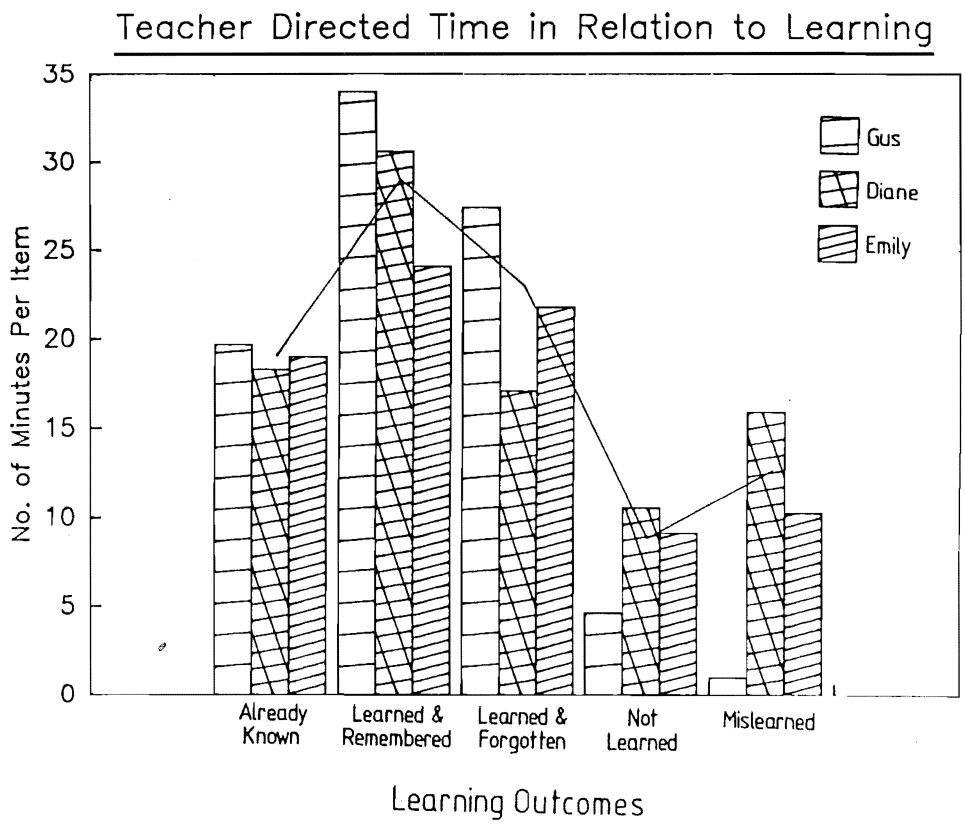


Figure 9

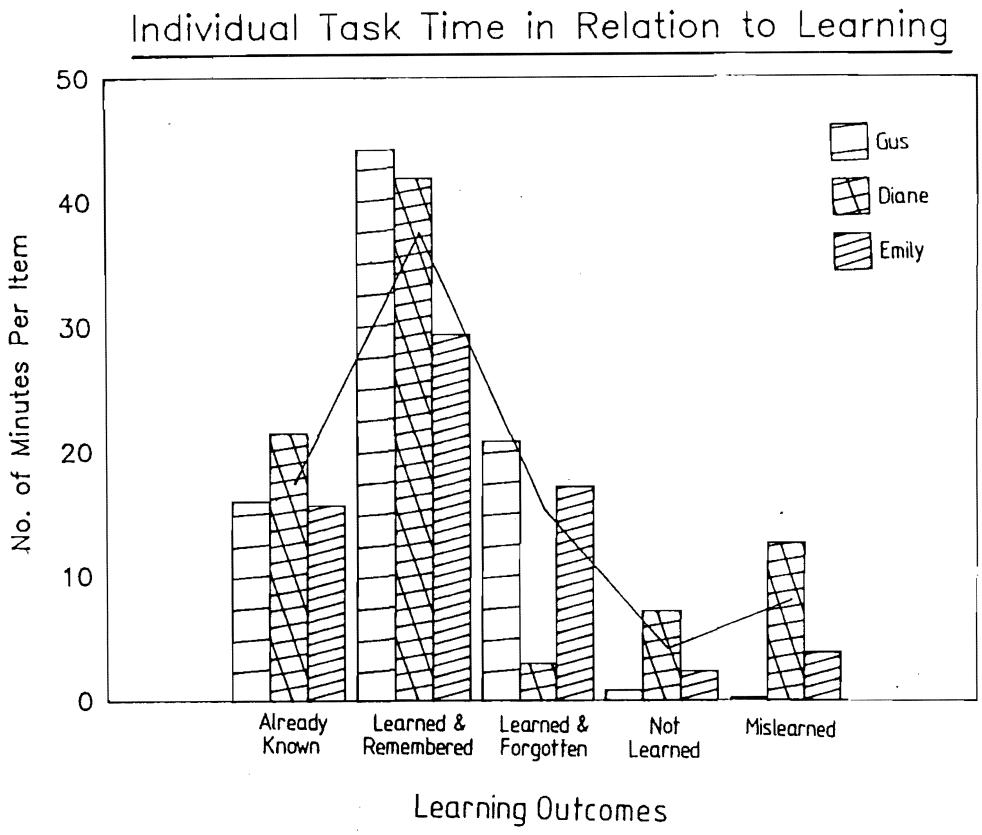
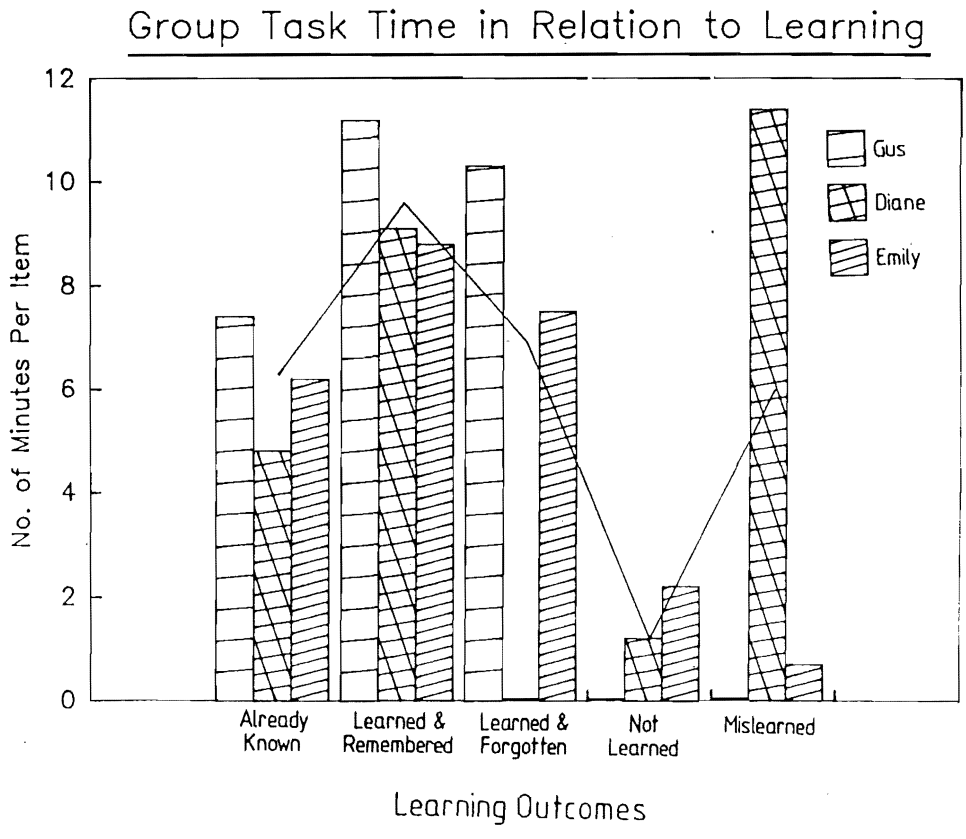


Figure 10



The analysis in Table 12 includes data for all items including the 4.9% of items which never occurred in any context during the unit. These items have been excluded in Table 13 so that the averages are for time spent on the content of items which actually occurred.

It can be seen in Table 13 that all three pupils spent over an hour, on average, on items which they learned and remembered. Gus's average of about an hour and a half reflects the longer time that he had an opportunity to interact with all tested unit content. Diane, who was absent for one day, spent only 88.5% of the time that Gus spent on tested content. Emily, who was withdrawn on two occasions for dental treatment and who was also absent for one day, spent only 81.1% of the time that Gus spent on tested unit content. Gus's higher averages for time spent reflect the fact that he had additional opportunity to interact with relevant content when he was in the high ability reading group. The comparatively lesser amounts of time during which Gus experienced an opportunity to interact with content which he did not learn suggests that he was able to make more effective use, than Diane or Emily, of the opportunity to interact with content.

Diane's results differ markedly from Gus's and Emily's. She spent, on average, the same amount of time (20 minutes) on items that she learned and forgot and items that she failed to learn. She also spent considerably greater amounts of time (51.6 minutes) when she experienced an opportunity to interact with the content of items that she mislearned.

Emily's results are similar to Gus's except that she spent less time on content which she learned and slightly more time on content she failed to learn or mislearned.

It appears that Gus was aware of the critical importance of time for learning because, when asked what he would do to improve the unit if he were teaching, he replied:

Gus I think I'd do just about the same as Mr H.

I There's nothing else that you can think of that you might change? - that you think might really help children learn?

Gus ...(I would) put a couple more activities on the wall for them to think about and um give them more time doing it.

8.4 SPREAD OF PUPIL OPPORTUNITY TO INTERACT WITH CONTENT

The results show a strong consistent relationship between learning and (a) the number of episodes during which case study pupils experienced an opportunity to interact with content ($r = 0.88$), and (b) the number of days over which that opportunity occurred ($r = 0.85$). Thus, the number of different occasions on which specific content occurred was related to pupil learning (see Tables 12 and 13, and Figures 11 and 15).

As can be seen in Table 13, the case study pupils interacted with the content of items they learned, on average, 15.8 occasions over more than five school days. The number of opportunities to interact with content was more consistently related to learning for Gus and Diane than for Emily (see Table 14).

Gus and Diane had five or six more opportunities to interact with content which they remembered than with content which they learned and forgot. Emily had more

Figure 11

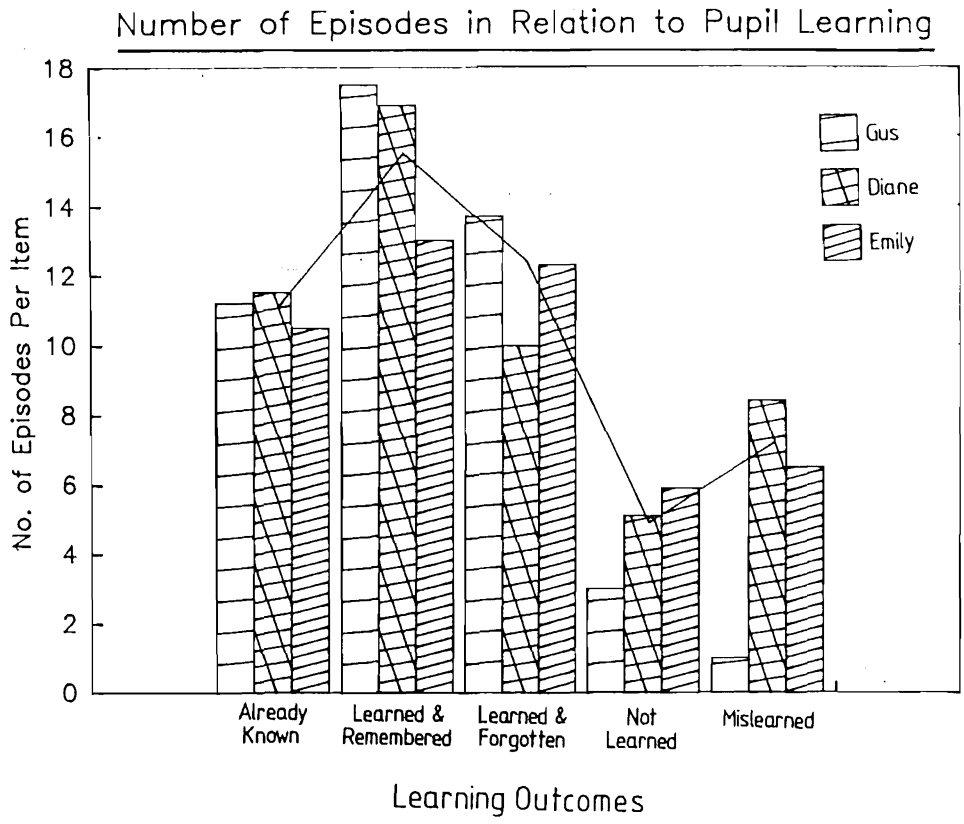


Figure 12

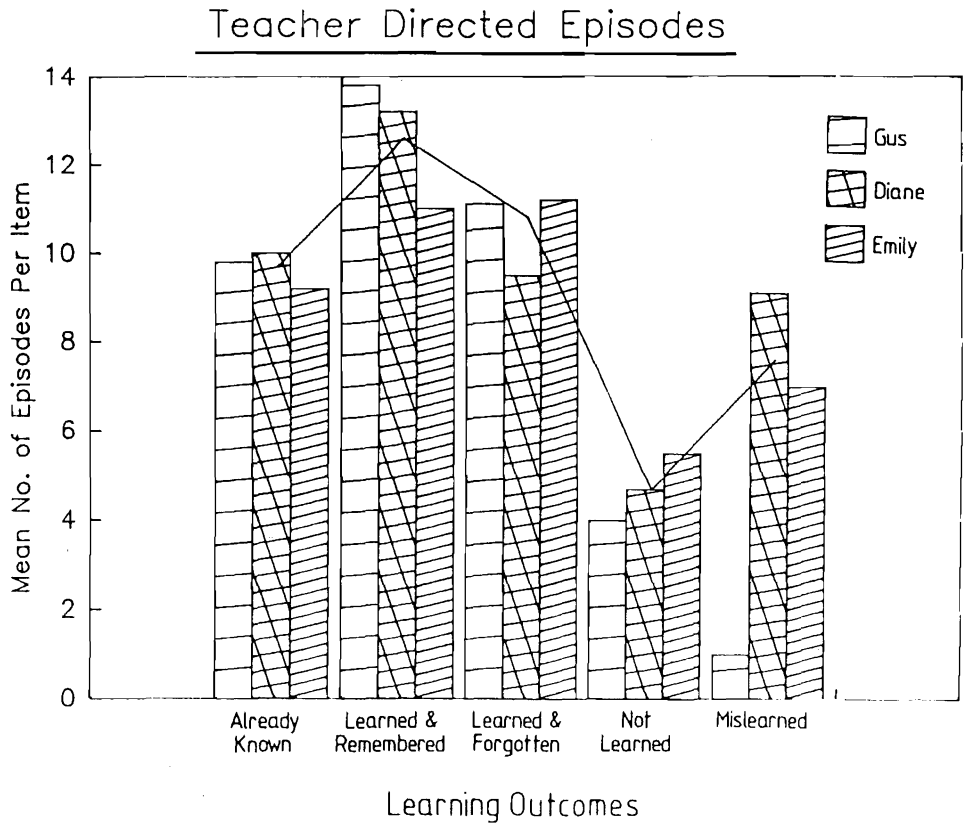


Figure 13

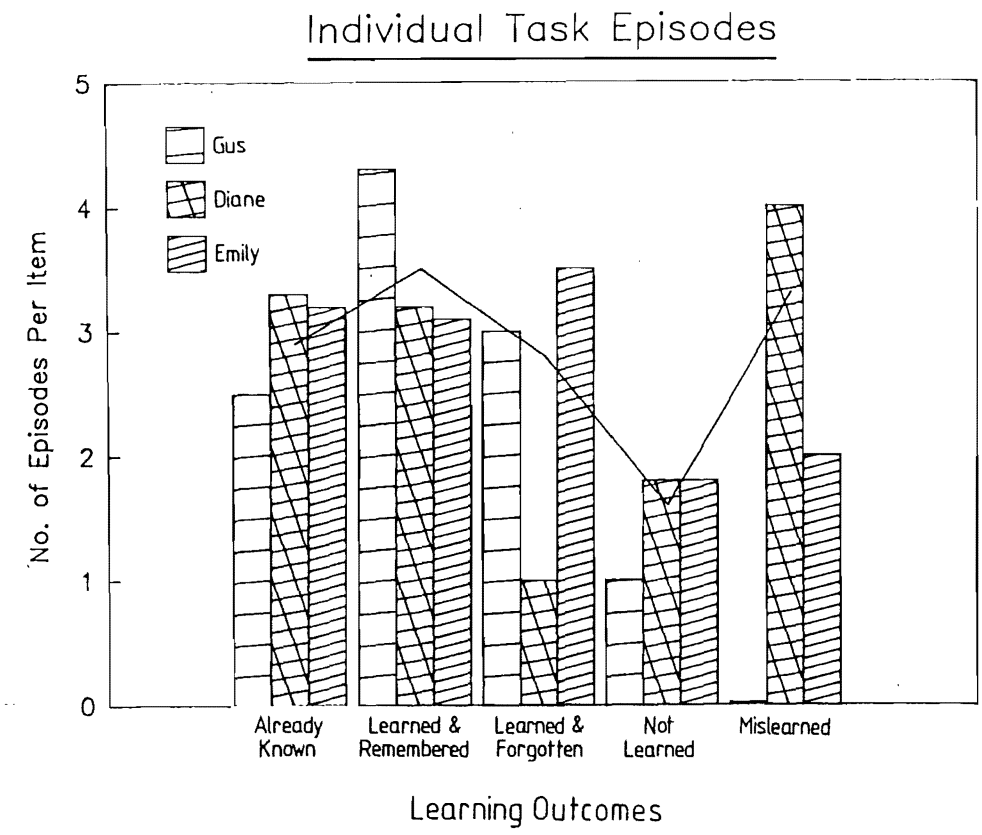


Figure 14

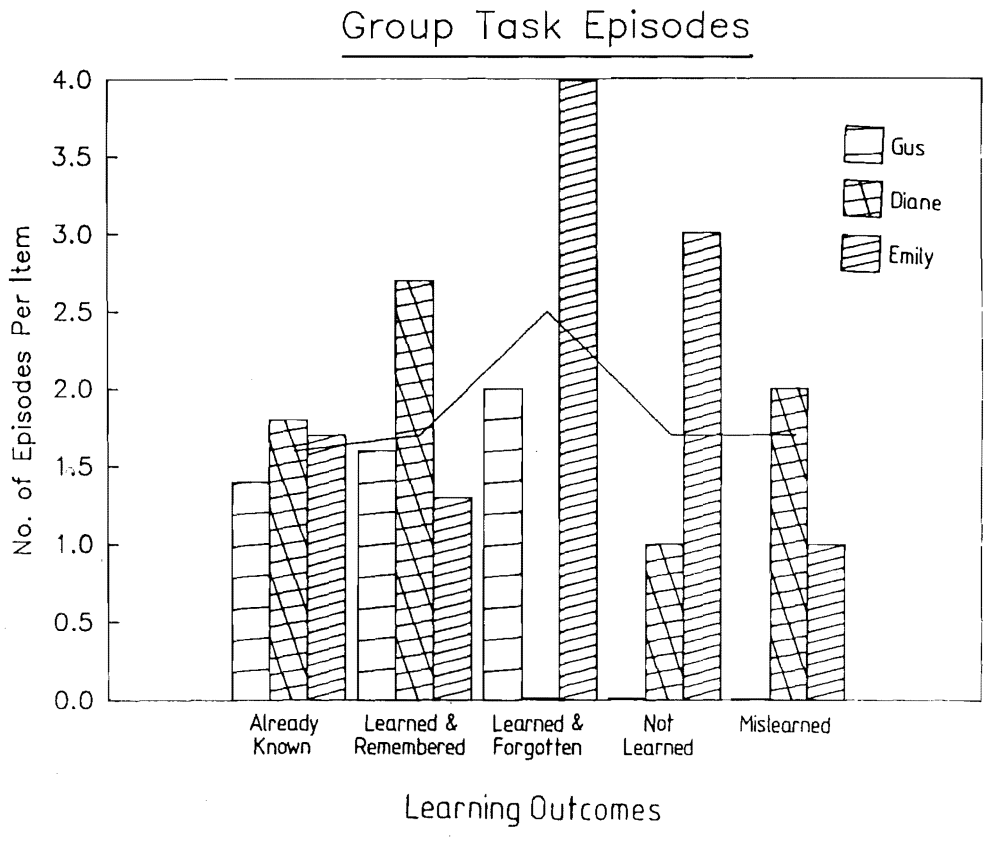


Figure 15

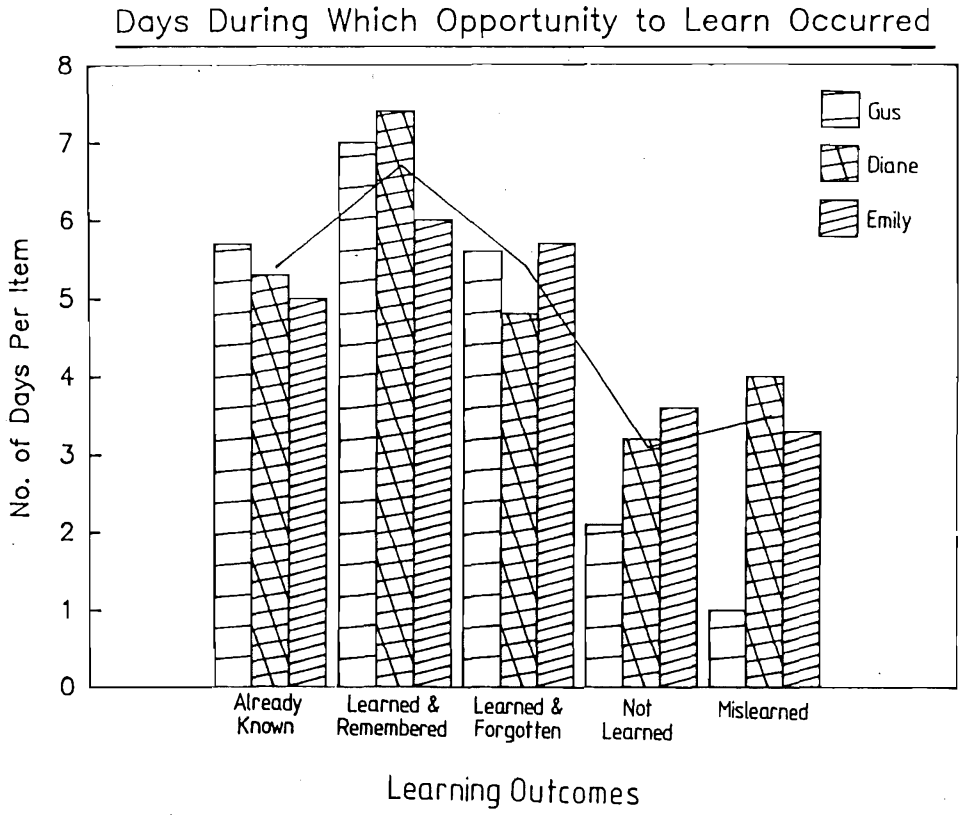

Days During Which Opportunity to Learn Occurred
No. of Days Per Item
0
1
2
3
4
5
6
7
8
Gus
Diane
Emily
Already Known
Learned & Remembered
Learned & Forgotten
Not Learned
Mislearned
Learning Outcomes

Table 15

Time Spent in Different Task Contexts in Relation to Pupil Learning (Means Calculated for All Items)

	Task Context						
	T-D Lessons		Ind.Task Activity		Group Task Activity		Total Time
Pupils	Mins.	%	Mins.	%	Mins.	%	Minutes
			Items Already Known				
Gus	19.7	45.7	16.0	37.1	7.4	17.2	43.1
Diane	18.3	41.0	21.5	48.2	4.8	10.8	44.6
Emily	19.0	46.6	15.7	38.5	6.2	15.2	40.8
Mean	19.1	44.5	17.5	40.8	6.3	14.7	42.9
			Items Learned and Remembered				
Gus	34.0	38.0	44.2	49.4	11.2	12.5	89.4
Diane	30.6	37.5	41.9	51.4	9.1	11.2	81.6
Emily	24.1	38.7	29.4	47.2	8.8	14.1	62.3
Mean	29.0	38.1	37.5	49.3	9.6	12.6	76.1
			Items Learned and Forgotten				
Gus	27.4	46.8	20.9	35.7	10.3	17.6	58.6
Diane	17.1	85.1	3.0	14.9	-	-	20.1
Emily	21.8	46.9	17.2	37.0	7.5	16.1	46.5
Mean	23.0	50.8	15.4	34.0	6.9	15.2	45.3
			Items Not Learned				
Gus	4.6	85.2	0.8	14.8	-	-	5.4
Diane	10.5	55.9	7.2	38.3	1.2	6.4	18.8
Emily	9.1	66.9	2.4	17.7	2.2	16.2	13.6
Mean	8.8	62.0	4.2	29.6	1.2	8.5	14.2
			Items Mislearned				
Gus	1.0	100.0	-	-	-	-	1.0
Diane	15.9	39.7	12.7	31.7	11.4	28.4	40.1
Emily	10.2	68.9	3.9	26.4	0.7	4.7	14.8
Mean	12.6	47.2	8.1	30.3	6.0	22.5	26.7
	Percentage of Time Across All Conditions						
		43.7		42.3		14.0	

opportunities, on average, to interact with content which she forgot than she had to interact with content she remembered.

All three pupils, however, had far fewer opportunities (about four to six episodes) to interact with content they failed to learn. Content was not learned, on average, when it occurred over less than 4.5 school days.

Emily perceived the number of opportunities to interact with content as important and when asked if there was anything about the unit she would change to make sure that children learned, she responded:

> (I would) explain it more clearly. And go over it again if some people don't know what they're talking about.

8.5 OPPORTUNITY TO INTERACT WITH CONTENT IN DIFFERENT TASK CONTEXTS

In Table 15 it can be seen that over 80% of items learned and remembered occurred in multiple task contexts: teacher-directed lessons and individual tasks and group tasks, or teacher-directed lessons and individual tasks, or teacher-directed lessons and group tasks. Almost 60% of items learned and forgotten occurred in multiple task contexts. Content which was learned and forgotten was much more likely to have occurred only in teacher-directed lessons than content which was learned and remembered.

Less than 30% of items not learned occurred in multiple task contexts and few of these items (7.3%) occurred in all three task contexts. Content which was not learned rarely occurred in group task situations for Diane and

Emily and never occurred in a group task for Gus.

Only 14.6% of items which were learned and remembered occurred only in one task context (teacher-directed lessons) and almost 60% of items not learned occurred in only one task context (teacher-directed lessons or individual tasks).

8.6 TIME SPENT IN TEACHER-DIRECTED LESSONS, INDIVIDUAL TASKS AND GROUP TASKS

Before examining the relationship between time spent in task contexts and pupil learning it is necessary to establish the extent to which tested content actually occurred in different task contexts. Almost all items for all three pupils (93.3%) occurred during teacher-directed lessons. Only half the items (50.2%) occurred in an individual task context and less than a quarter (23.6%) of the items occurred in a group task context.

Table 16 contains an analysis of the average minutes spent in each task context during which the case study pupils experienced the opportunity to interact with content (according to learning outcomes). The means in Table 16 have been averaged across all items in order to facilitate an overall analysis in relation to time spent. This is an artificial analysis particularly with respect to group tasks. A quarter of the items occurred in group tasks and took up considerable time because of the nature of pupil-directed group activity. The averages for actual time spent calculated only for items which involved teacher-directed lessons, individual tasks or group activity are shown in Figures 8, 9, and 10, and reported in-depth in the results for different task contexts in Chapters 9, 10 and 11.

Table 16

Analysis of Pupil Opportunity to Interact with Content in Each of the Three Task Contexts and Combinations of the Three Task Contexts in Relation to Pupil Learning

	Task Context(s)					
Pupils	All 3	TD/IND	TD/GP	TD	IND	NO OPP
	Percentage of Items					
	Items Already Known					
Gus	25.6	32.6	7.0	30.2	2.3	2.3
Diane	20.7	24.1	10.4	37.9	3.5	3.5
Emily	14.3	21.4	7.1	53.6	3.6	0.0
Mean	21.0	27.0	8.0	39.0	3.0	2.0
	Items Learned and Remembered					
Gus	26.7	46.7	6.7	20.0	0.0	0.0
Diane	21.4	71.4	0.0	7.1	0.0	0.0
Emily	20.0	50.0	10.0	15.0	0.0	5.0
Mean	22.4	55.1	6.1	14.3	0.0	2.0
	Items Learned and Forgotten					
Gus	42.9	14.3	0.0	42.9	0.0	0.0
Diane	0.0	50.0	0.0	50.0	0.0	0.0
Emily	16.7	50.0	0.0	16.7	0.0	16.7
Mean	23.5	35.3	0.0	35.3	0.0	5.9
	Items Not Learned					
Gus	0.0	22.2	0.0	44.4	11.1	22.2
Diane	10.5	21.1	0.0	63.2	0.0	5.3
Emily	7.7	23.1	0.0	61.5	0.0	7.7
Mean	7.3	22.0	0.0	58.5	2.4	9.8
	Items Mislearned					
Gus	0.0	0.0	0.0	100.0	0.0	0.0
Diane	11.1	11.1	11.1	44.4	0.0	22.2
Emily	12.5	0.0	0.0	75.0	0.0	12.5
Mean	11.1	5.6	5.6	61.1	0.0	16.7

Note TD = Teacher-Directed IND = Individual GP = Group

No content was observed to occur only in a group task context. It is possible that inaudible pupil conversations occurred about content which did not occur in other contexts. Generally, however, pupil conversations during group tasks concerned content discussed during teacher directed lessons.

The analysis of time spent in different task contexts shows that the more time spent in each task context the more likely the case study pupils were to have learned. All items, on average, took up more time in teacher-directed lessons than in either individual tasks or group tasks except for items learned and remembered. Thus, individual task opportunity was particularly important for pupil remembering.

It can be seen in Table 16 that, for all three pupils, items learned and remembered involved proportionately more individual task time and proportionately less teacher-directed time than items learned and forgotten. Items learned and remembered had proportionately less teacher-directed time than any other set of items. The time spent in an individual task context was more consistently related to pupil learning than that spent in teacher-directed lessons (see Table 14). The time spent in group tasks was relatively inconsistently related to pupil learning which is not surprising given that fewer than a quarter of the items were involved in group tasks.

Items not learned which took up the least class time on average involved the highest proportion of teacher-directed time for Diane and mislearned items took up the highest proportions of teacher-directed time for Gus.

Proportionately more time was spent in group tasks for items learned by Gus and Diane but about the same proportion of time was spent in group tasks for items not learned as for items learned by Emily. For all three pupils more actual time in relevant group tasks was spent, on average, on learned items.

It is interesting to note that in this study the percentage of time pupils spent in individual and group tasks on tested content (56.3%) is similar to the

percentage of time pupils were found to spend on 'seatwork' in second-, fifth-, and sixth-grade classrooms studied by McDonald (1975) and Good and Beckerman(1978).

8.7 Summary

Pupil opportunity to interact with content was strongly related to case study pupil learning. This finding concurs with the strong positive relationship found to exist between pupil learning and pupil time spent in recent studies (Anderson, 1976; Anderson & Scott, 1978; Bloom, 1974; Good & Beckerman, 1978; Hoge & Luce, 1979; Hops & Cobb, 1974; McKinney et al., 1975; Rosenshine, 1979; Stallings, 1980; Stuck, 1980; Walker & Hops, 1976; Wyne & Stuck, 1979).

The procedures used to calculate this variable provided precise information about actual time spent on specific content. The findings are important because they describe actual time spans such as the hour and a quarter, on average, spent on the content of items learned and remembered. This kind of information is not obtained from investigations which report results as correlations or statistical significance tests.

In addition to the length of time spent on specific content, the number of times during which content occurred was also found to be related to pupil learning.

The overview of pupil opportunity to learn in different task contexts indicates that opportunity to interact with content in teacher-directed lessons <u>and</u> pupil tasks was important to learning. Pupil task opportunity was particularly important for long-term learning.

The finding that more time spent in group and individual tasks was related to learning in this study contrasts with Soar's (1973) finding that when pupils worked in pupil-directed groups, negative correlations with achievement occurred.

There was limited pupil choice in the selection and sequencing of tasks although the tasks were set by T. The pupils decided seating patterns and were able to move freely about the classroom. Thus the finding that length of task opportunity was related to pupil achievement in this study is in contrast with negative correlations between pupil choice factors and pupil learning in studies by Soar (1973), Solomon & Kendall (1976), and Stallings & Kaskowitz (1974).

Pupil behaviour patterns in each of the three task contexts are reported in the following three chapters. Pupil behaviour patterns during teacher-directed lessons were unique to that context. Pupil behaviour patterns during individual task context time and group task context time have been reported separately because an exploratory data analysis revealed that observably identical behaviours (for example, rubbing out) were differentially related to learning outcomes in the different task contexts.

8.8 IMPLICATIONS OF THE TIME SPENT FINDINGS FOR INTERPRETING PUPIL BEHAVIOUR FREQUENCIES IN RELATION TO PUPIL LEARNING

Given that more opportunity to interact with content was related to pupil learning how do we interpret the results of the relationship between frequencies of occurrence of individual pupil behaviours and pupil learning?

There are three possible relationships between individual variables and pupil learning: (a) a variable is positively related to learning (more of it occurred for content learned than for content not learned), (b) a variable is negatively related to learning (more of it occurred for content not learned than for content learned), or (c) a variable is not related to learning (about the same amount of it occurred irrespective of learning outcome).

If time spent were the only variable influencing learning (given pupil opportunity to interact with content) then the pattern of pupil activities would be unrelated to pupil outcomes. Either the pattern of pupil activities would be the same regardless of learning outcome, or the pattern of activities would vary randomly across the different learning outcomes. In either case, the only thing that would vary with learning outcome would be time spent. However, if some variables were more facilitative of learning within the time spent, and some more inhibitive, then there would be a different pattern of behaviours associated with different learning outcomes. In order to establish whether there were variables which have a particular relationship to pupil learning over and above time spent it is necessary to hold the time spent constant. As has been discussed in Chapter 5, time spent has been held constant in the reporting of rates per hour. In the following chapters it is apparent that some behaviours and opportunities occurred for proportionately more of the time spent on content learned and remembered.

Now consider the <u>kind</u> of relationship between individual variables and pupil learning, given an assumption that a factor such as mental processing is a key intermediary variable in pupil learning. If a pupil behaviour is positively related to pupil learning by virtue of the fact that it does no more than take up the time spent, then it is difficult to establish to what extent, and how, that

behaviour facilitates learning. It is possible that such behaviour is only incidental (for example, pupil coughing) and that more of it occurred during pupil interaction with content which was learned because more time was spent on this content. Such a behaviour is not causally related to learning in any way. It may, however be important to identify the fact that behaviours which are in this category are not inhibiting learning.

Alternatively, it is possible that a behaviour facilitates or brings about learning given sufficient time. In this case it would follow that learning is a process which takes up time because of the nature of the mental processes involved and that the behaviour in question facilitates learning in the weak sense that it makes it possible for learning to occur.

If a pupil behaviour takes up <u>proportionately</u> more of the time spent on learned content than it takes up of time spent on content not learned, then it could be argued to be a stronger contender for causal status with respect to pupil learning. Even then however, although it <u>may</u> be facilitative of the kind of mental processing that brings about pupil learning, it could alternatively be a consequence of the kind of mental processing that facilitates pupil learning. Whether it is a direct cause or a consequence or 'symptom' of learning it should provide some insight into the nature of learning.

If a pupil behaviour is negatively related to pupil learning it could be argued to be either inhibiting the kind of processing that brings about learning or a consequence of the kind of mental processing which is insufficient or inadequate to bring about learning. Behaviours which are negatively related to learning in both amount and rate would be strong contenders for consideration as directly inhibitive of pupil learning. Behaviours or opportunities which were <u>consistently</u>

related to learning outcomes in both amount and rate provide the evidence for the theory advanced in Chapter 14.

CHAPTER 9

RESULTS FOR TEACHER-DIRECTED LESSONS

9.1 OVERVIEW OF RESULTS FOR TEACHER-DIRECTED LESSONS

Most (93.3%) of the tested content occurred either partly or completely within a teacher-directed context. A typical teacher-directed lesson involved the class sitting on a large mat in front of the teacher who was seated next to a mobile blackboard. T introduced concepts, directed discussion and noted key words on the blackboard. Books, pictures and charts were used frequently during these lessons. This kind of format was used, for example, for introductory lessons on each of the three unit subtopics: erosion, pollution and endangered animals.

Other kinds of teacher-directed lessons included guided silent reading, demonstrations by T using simulated models, pupil mime to teacher directions and T reading stories or articles.

Typically, content occurred in a teacher-directed context before it occurred in a pupil activity context. Specific content generally recurred during several teacher-directed lessons (Figure 12). The content of each item learned and remembered was discussed on average, 16 times over about seven school days (See Table 12). Even content not learned occurred, on average, five or six times during at least three different lessons.

Three overall analyses of teacher-directed lessons are discussed in this chapter. The first analysis of public talk is reported in section 9.2. The total time involved in teacher-directed lessons was subdivided into

opportunity to attend to teacher talk and opportunity to attend to teacher-pupil discussion. The ratio of opportunity to attend to teacher talk and opportunity to attend to teacher-pupil discussion was compared for sets of items with different test outcomes.

In addition to the analysis of public talk the total time involved in teacher-directed lessons was analyzed according to pupil opportunity to attend to visual resources such as blackboard work, demonstrations, charts and pictures. These results are reported in section 9.3 as are the results for the relationship between pupil learning and opportunity to attend to teacher-directed mime.

In section 9.4 the pattern of non-passive pupil behaviours which occurred within the opportunity to attend to teacher-directed lessons was analyzed in relation to pupil learning. There were eight non-passive behaviours counted: interactions with T, hand raises, pupil verbalizations to self (under the breath), participation in chorus responses, informal mime, fiddling, verbal interactions with peer(s) and non-verbal interactions with peers.

9.2 OPPORTUNITY TO ATTEND TO TEACHER TALK OR TEACHER-PUPIL DISCUSSION

Figure 16

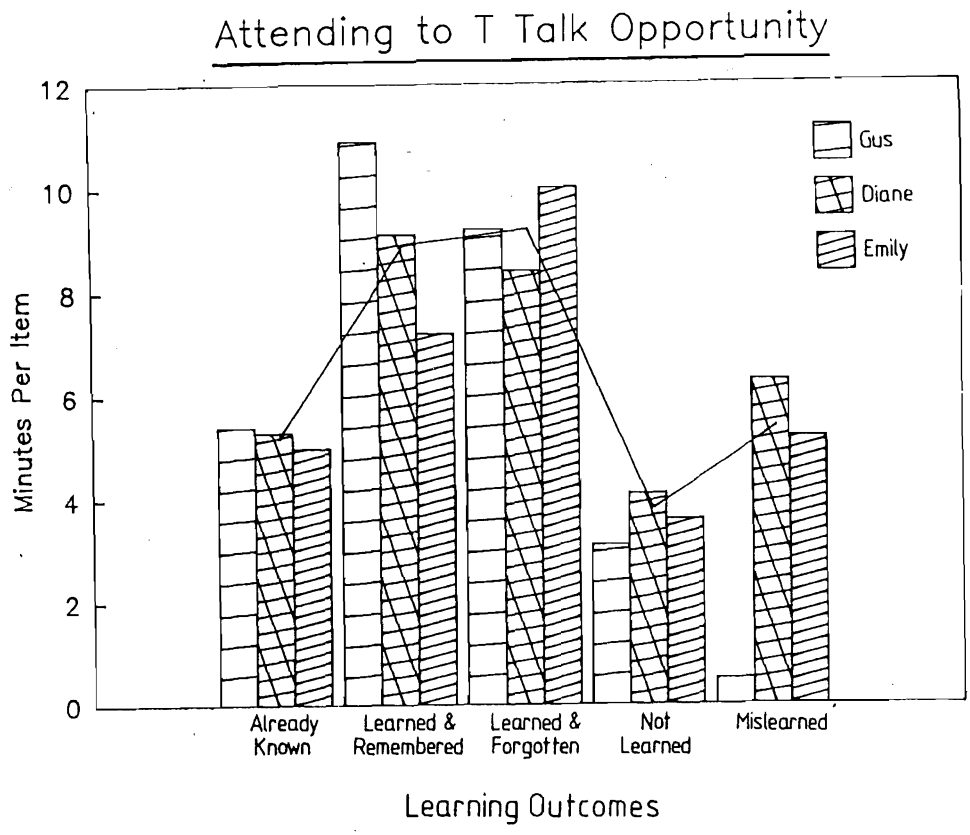
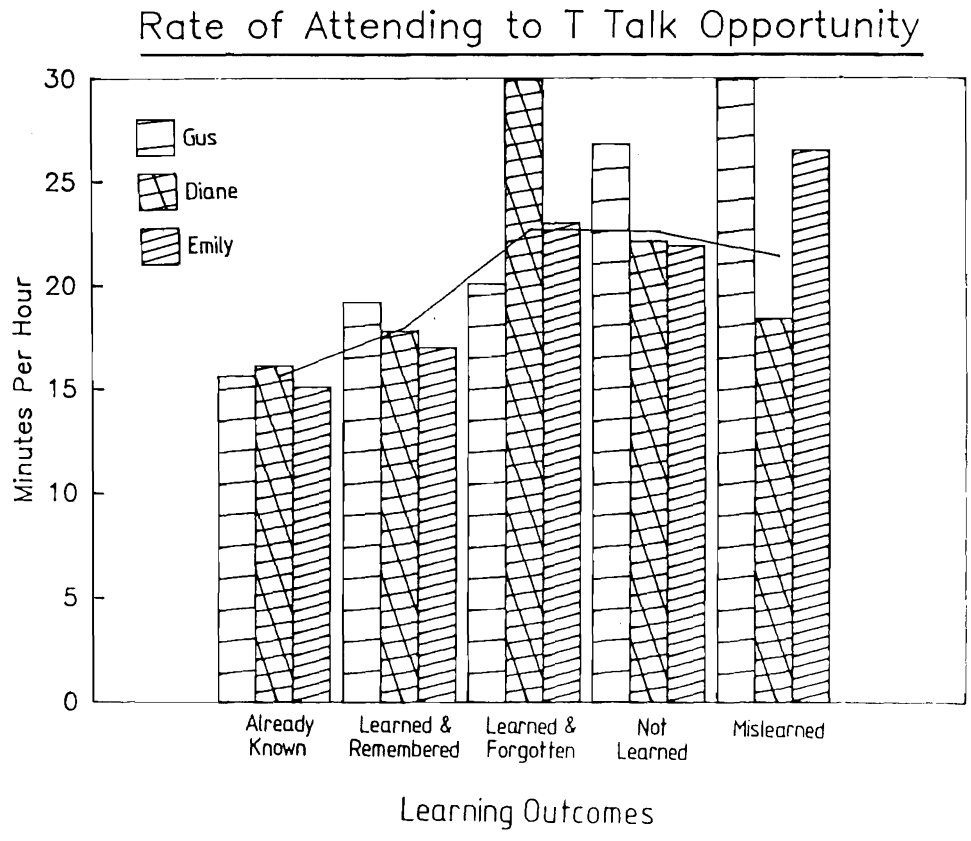


Figure 17



9.2.1 Mean Minutes of Actual Opportunity to Attend to Teacher Talk and Teacher-Pupil Discussion

Each interval of data was classified either as opportunity to attend to teacher-talk or as opportunity to attend to teacher pupil discussion. The following is an example of the transcript of a 30-second interval, during teacher-directed time, which involved only teacher-talk:

T They get ten times as much rain as we do in the year. That's why the West Coast is very green - lots of native bush and so on. Over this side you don't get much native bush because it's not wet enough... because native bush needs plenty of moisture...So we get wind over here then we get clouds - then, of course, we get lots of rain. Some of the rain from our lakes/*evaporates...
*[next interval begins]

The following is an example of an interval which involved teacher-pupil discussion about the concept of <u>environment</u>:

P Animals.

P Everything!

P Nature.

T I haven't used that word once but what have I used instead of the word, 'nature'? What's something we've used instead of

Figure 18

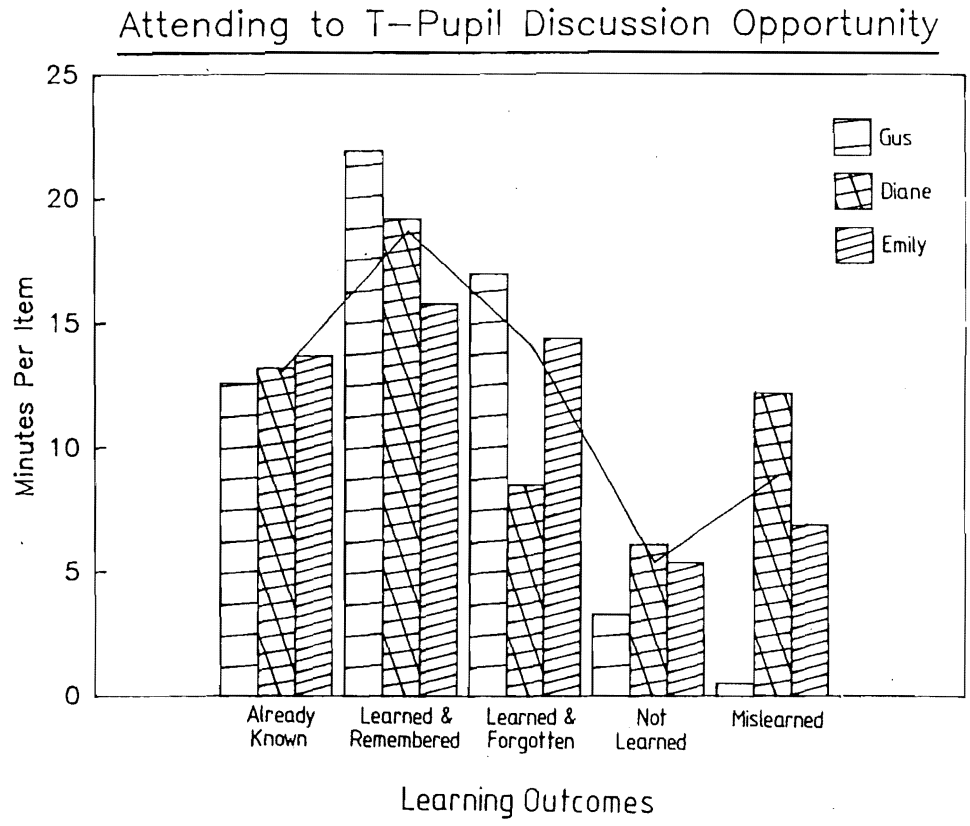


Figure 19

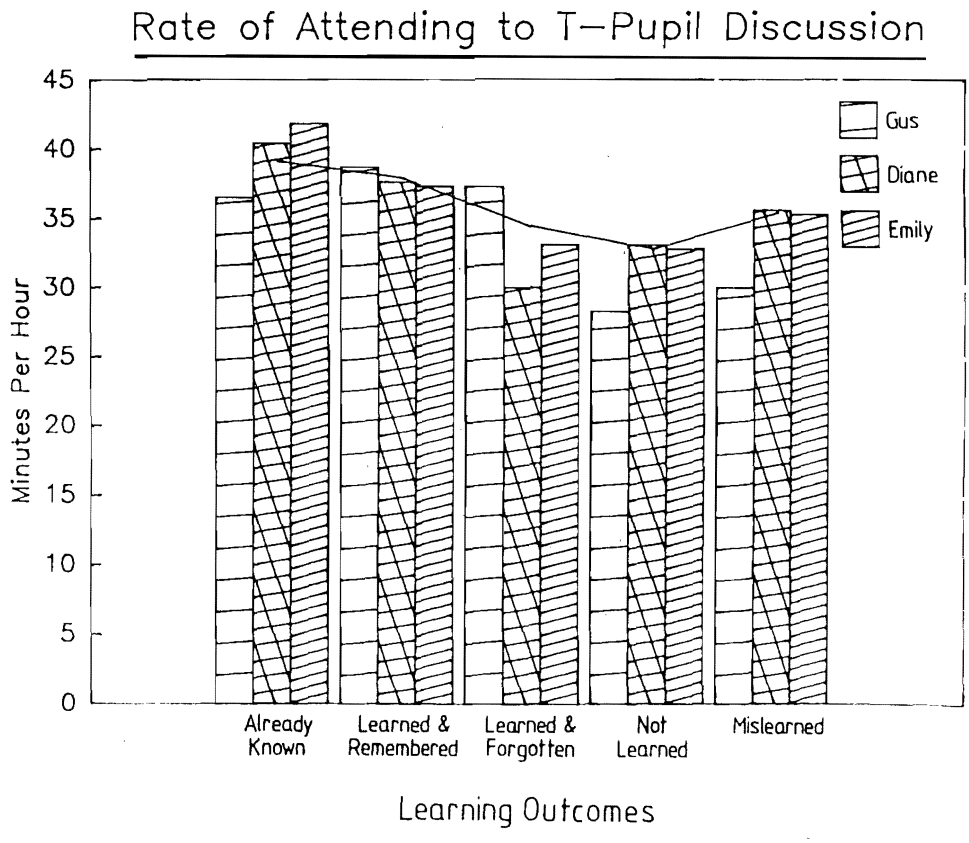


Table 17

Mean Minutes (Total Time) of Opportunity to Attend to Teacher Talk and Teacher-Pupil Discussion in Relation to Pupil Learning: Means Calculated Only for Items Taught During Teacher-Directed Time
(93.3% of all Items)

Pupils	Attending Focus: Teacher	T-Pupil	Other*	Total Time
	Items Already Known			
Gus	5.4	12.6	2.7	20.7
Diane	5.3	13.2	1.2	19.7
Emily	5.0	13.7	1.0	19.7
Mean	5.2	13.1	1.8	20.1
	Items Learned and Remembered			
Gus	10.9	21.9	1.2	34.0
Diane	9.1	19.2	2.3	30.6
Emily	7.2	15.8	2.3	25.3
Mean	8.9	18.7	2.0	29.6
	Items Learned and Forgotten			
Gus	9.2	17.0	1.2	27.4
Diane	8.4	8.5	0.2	17.1
Emily	10.0	14.4	1.8	26.2
Mean	9.2	14.1	1.1	24.4
	Items Not Learned			
Gus	3.1	3.3	0.5	6.9
Diane	4.1	6.1	0.9	11.1
Emily	3.6	5.4	0.8	9.8
Mean	3.8	5.4	0.6	9.7
	Items Mislearned			
Gus	0.5	0.5	0.0	1.0
Diane	6.3	12.2	2.0	20.5
Emily	5.2	6.4	0.0	11.6
Mean	5.4	8.9	0.8	15.1

Note. Other includes a mean of all the total half minute intervals involving pupil reading during teacher directed lessons.

the word 'nature'?

P (Inaudible incorrect response).

T No, we're talking about environment.
The natural things around us although/
*our *[next interval begins]

The relationship between pupil opportunity to attend to teacher talk and pupil learning can be seen in Figure 16. More opportunity to attend to teacher talk was associated with learned content than with content which was not learned. There was about the same length of opportunity to attend to teacher talk about content which was learned and forgotten as there was about content which was learned and remembered.

The relationship between pupil opportunity to attend to teacher-pupil discussion and pupil learning can be seen in Figure 18. Not only was there more opportunity to attend to teacher-pupil discussion about content which was learned but also there was more opportunity to attend to teacher-pupil discussion about remembered content than there was to attend to content which was learned but forgotten.

Thus more opportunity to attend to any relevant public talk was associated with pupil learning but more opportunity to attend to teacher-only talk did not seem to facilitate remembering whereas more opportunity to attend to teacher-pupil discussion appears to have facilitated remembering.

The average time during which pupils experienced an opportunity to attend to public talk about tested content is shown in Table 17. Because the data collection procedures involved continuous observation

the average times given represent the actual (or slight over-estimations of) time spent. About nine minutes of teacher talk occurred on average, about the content of learned items whereas about four minutes of teacher talk occurred on average, about the content of items which were not learned. Much more opportunity to attend to teacher-pupil discussion (just under 19 minutes on average, about the content of each item) occurred for content learned and remembered. There was also more teacher-pupil discussion (about 14 minutes on average) about content which was learned and forgotten. There was only about five minutes of teacher-pupil discussion on average, about the content of items which were not learned. For known content there was over twice as much opportunity to attend to teacher-pupil discussion (13.1 minutes per item on average) as there was to attend to teacher talk.

Both the actual amount of teacher talk and the amount of teacher-pupil discussion were consistently related to pupil learning outcomes overall (r= 0.53 and r = 0.70). See Table 19.

9.2.2 Comparative Rate of Opportunity to Attend to Teacher Talk and Teacher-Pupil Discussion

Given the general relationship that existed between the total time that pupils were exposed to content and the different learning outcomes, it is difficult to determine the relative significance of different types of exposure, without holding the total time constant. This was done by calculating the frequency or 'rate' of different types of exposure to content per hour of total exposure. It can be seen in Figure 17 that the lowest <u>rates</u> of teacher talk were associated with known content and content which was learned and remembered.

Table 18

Rate of Opportunity to Attend to Teacher Talk and Teacher-Pupil Discussion in Relation to Pupil Pupil Learning (Minutes Per Hour)

	Rate Per Hour	
	Attending Focus	
Pupils	Teacher Talk	Teacher-Pupil Discussion
	Items Already Known	
Gus	15.6	36.5
Diane	16.1	40.4
Emily	15.1	41.8
Mean	15.6	39.1
	Items Learned and Remembered	
Gus	19.2	38.7
Diane	17.8	37.6
Emily	17.0	37.3
Mean	18.0	37.9
	Items Learned and Forgotten	
Gus	20.1	37.3
Diane	29.9	30.0
Emily	23.0	33.1
Mean	22.7	34.5
	Items Not Learned	
Gus	26.8	28.3
Diane	22.1	33.1
Emily	21.9	32.8
Mean	22.6	32.5
	Items Mislearned	
Gus	30.0	30.0
Diane	18.4	35.6
Emily	26.5	35.3
Mean	21.4	35.4

By contrast the lowest rate of teacher-pupil discussion was associated with content which was not learned.

The ratio of teacher talk to teacher-pupil discussion was 18.0 to 37.9 (that is, about 1:2) for content learned and remembered (see Table 18). The greatest proportion of public pupil talk occurred when the content was already known by the case study pupils. There was relatively more teacher talk about content which was neither known nor learned and remembered. The mean ratios of opportunity to attend to teacher talk to opportunity to attend to teacher-pupil discussion were closely similar (at about 22 minutes of teacher talk per hour to 33 minutes of teacher-pupil discussion per hour) for the content of items learned and forgotten, the content of items which were not learned and the content of items which were mislearned.

As can be seen in Table 19 these results were generally consistent except for the rate of teacher-pupil discussion to which Diane had an opportunity to attend in relation to her learning.

An analysis of teacher talk about content which the case study pupils either failed to learn or mislearned suggested that extended teacher anecdotes might be partially responsible for this negative relationship. In these anecdotes T related unfamiliar content to his own experience. For example, T described his own experience of hearing the roaring of a massive avalanche during an excursion to Mount Cook. Emily later wrote of avalanches as agents of erosion:

> A (sic) avalanche is snow falling
> and it is very loud, I think you
> might be able to hear it a mile
> away.

Although the observers noted that the children were very interested in these anecdotes, they seemed to have confused the children's understanding of the content When T used the relevant experiences of class members to teach a concept (for example, the freezing of water in glass bottles to bring about expansion and a subsequent explosion) the case study pupils were less confused.

The results for teacher-pupil discussion contrasted with the results for opportunity to attend to teacher talk. Not only was more teacher-pupil discussion associated with long-term pupil learning but also a higher proportion of teacher-pupil discussion <u>within</u> the total opportunity to attend to public talk was associated with long-term learning.

In some ways the content of teacher-pupil discussion was similar to teacher talk. Both kinds of talk involved definitional statements, explanations, and examples of the concept or proposition being discussed. However, the treatment of content during teacher-pupil discussion was different in two respects. Firstly, as discussed above, the new content was linked to pupil experiences rather than teacher experiences. Secondly, the new content was clarified in relation to <u>inappropriate</u> examples and instances. That is, generally when teacher-only talk occurred T would provide a number of metaphors and examples to illustrate and clarify new content. When teacher-pupil discussion occurred the pupils would not only provide appropriate examples of the new content from their own experience and knowledge, they would also supply examples and instances of the new content that were inappropriate and T would point out how and why their responses were inappropriate. Other kinds of pupil contributions occurred during teacher-pupil discussion from time to time (for example, the pupils would ask a

series of direct questions of T in relation to new content, or T would elicit definitions from the pupils). However, the discussion of inappropriate examples and pupil experiences was consistently characteristic of this talk.

The interview data was congruent with the quantitative result suggesting the importance of teacher-pupil discussion in facilitating learning. Case study pupil memories for actual teacher phrases were memories of teacher statements or questions made in the course of teacher-pupil discussion. The incident Diane remembered in relation to the definition of 'environment' occurred in the course of the teacher-pupil discussion cited at the outset of this section:

Diane I can remember Mr H saying:
'The environment around us.'

Diane's memory of the statements and questions made by T in the course of teacher-pupil discussion is also apparent in the match between the following recollection (during the interview) and the transcript of relevant discussion:

[Memory]

Diane I remember Mr H telling us that.
Not for <u>some</u> living things
but for <u>all</u> living things.

[Actual discussion]

T Something else I mentioned about water?

P We need it.

T Yes, not only men. Not only animals. Not only ... We'll put all those together and what do you get?

P Living things.

T All living things need water. Now, what happens if it's polluted?

P We die.

T Fish might die or?

Gus's memories for T's statements and questions also involved intervals during which both T and other class members participated. Even though T first outlined the quantity of water involved in the production of a kilogram of beef during an extended period of teacher talk, Gus remembered the follow-up session when T asked the pupils questions about what he had taught earlier:

Gus Mr H asked us: 'How much do you think it would take to get one kilogram of meat?'

This result is consistent with the experimental results obtained by Church (1976) in which replacing teacher-pupil discussion with teacher only talk covering identical content reduced pupil learning.

There could be a number of different interpretations placed on these results. One possibility is that the higher amount of teacher-pupil discussion about the content of items learned and remembered reflects the

fact that the pupils had learned that content early in the unit and were more likely to publicly share content which they had learned.

A second possibility is that the pattern of teacher-pupil discussion was facilitating learning in some way. Cazden (1983) pointed out that pupil comments during classroom discourse could plausibly serve a number of functions such as enabling the teacher to assess pupil learning or helping the pupils learn how to accomplish an academic task. The evidence from this study indicates that the pupils may have been learning directly from the comments made by their peers. Gus explained that he felt he learned most in teacher-directed lessons because:

> Some other people are always telling the teacher things and I'm always listening - most of the time, anyway- to what they're saying so I learn a bit of what they knew.

Gus also explained how he reacted when T was talking about something he already knew:

I Do you find very often that you're learning things you already know or that the teacher's teaching things you already know?

Gus Oh not very often but sometimes I do.

I Do you think ahead when the teacher's talking about the topic or do you think about other things?

Gus Sometimes, if I like the topic, I'm

> trying to think of little things to tell him that he might not have already mentioned...if he's telling me something that I already know I just keep on thinking but if he's telling me something I don't know I try and listen and see what it is.

Gus's responses indicate both that he particularly attended to the responses of other pupils and that he consciously attempted to ensure that T did not leave relevant information out. Gus's views are consistent with the results for teacher-directed lessons (Figures 18 and 19, and Tables 17 and 18) and with Morine-Dershimer's (1979) finding that children were more likely to remember the comments of their peers than the comments of their teacher.

Further evidence for the impact of teacher-pupil discussion upon pupil learning was apparent in the event of Gus's mislearning in relation to smog. Although Gus recognized smog as a kind of pollution in the immediate posttest he 'forgot' this one year later. In the interview Gus's uncertainty about this item was evident:

> I don't know. It just seems like smoke, sort of... When it's actually there and um 'cept that it doesn't actually come from smoke. It doesn't actually smoke; it's not really pollution. It's just weather now that I think of it, you know.

An examination of relevant class discussion showed this misconception in a response given by another pupil to T's request for adjectives to describe polluted air:

P Foggy.

T No, fog is not caused by...fog is just caused by moisture - it's not actually caused by pullution.

P I was thinking of smog.

T Well, that's...smog is a combination of the smoke and the fog. Fog is a natural thing.

T's explanation that smog is partly made up of fog - which is a natural thing, seems to have reinforced the pupil misconception. It seems plausible that Gus's misconception either arose from, or was reinforced by, this interlude. In spite of the fact that Gus spent more than two hours of class time in lessons and activities concerning smog this misconception inhibited long-term learning. Thus, not only was teacher-pupil discussion apparently effective in promoting learning but also it was a potential source of mislearning.

Table 19

Reliability Coefficients for Resource Attending Opportunity During Teacher-Directed Lessons

Attending Opportunity	Overall		Gus		Diane		Emily	
	Mean	Rate	Mean	Rate	Mean	Rate	Mean	Rate
Teacher Talk	0.53	0.43	0.56	0.67	0.35	0.52	0.00	0.90
Teacher-Pupil Discussion	0.70	0.63	0.72	0.79	0.88	0.00	0.60	0.70
No Visual Resource	0.00	0.00	0.00	0.00	0.00	0.21	0.53	0.49
Blackboard	0.86	0.74	0.76	0.00	0.88	0.68	0.79	0.93
Demonstration	0.82	0.63	0.73	0.59	0.50	0.61	0.84	0.69
Book	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Picture	0.82	0.57	0.87	0.68	0.30	0.46	0.75	0.79
Chart	0.52	0.00	0.67	0.00	0.14	0.00	0.33	0.55
Teacher Directed Mime	0.42	0.71	0.59	0.55	0.00	0.32	0.06	0.96

9.3 OPPORTUNITY TO ATTEND TO RESOURCES

In order to establish whether there were discernible and consistent relationships between pupil opportunity to attend to resources and pupil learning an analysis was carried out of the five visual resources most often used by T.

9.3.1 Absence of Visual Resources

The amount of time when public talk (teacher talk or teacher-pupil discussion) was not supplemented by some visual resource during the Conservation Unit was less than one minute per item on average, over all items. (See Table 20).

It can be seen in Figure 20 that absence of visual resources was differentially associated with learning outcomes for the three case study pupils. For Diane and Gus, the proportion of public talk without visual resources was higher when the content was not learned or learned and forgotten. The results for Emily are in direct contrast. Public talk without visual resources was more likely to be associated with content which Emily learned and remembered. This pattern of result was relatively consistent for Emily across the three data sets ($r = 0.53$).

The rate of public talk without visual resources was highest, by one minute per hour, for the content of items not learned when calculated across the data for all three pupils (see Figure 21 and Table 21). However, Emily's pattern, again, was in direct contrast with the pattern for Gus and Diane. For Emily, the occasions which did not include visual resources were more likely to be associated with content which she learned. With Gus and Diane, however, the occasions

Figure 20

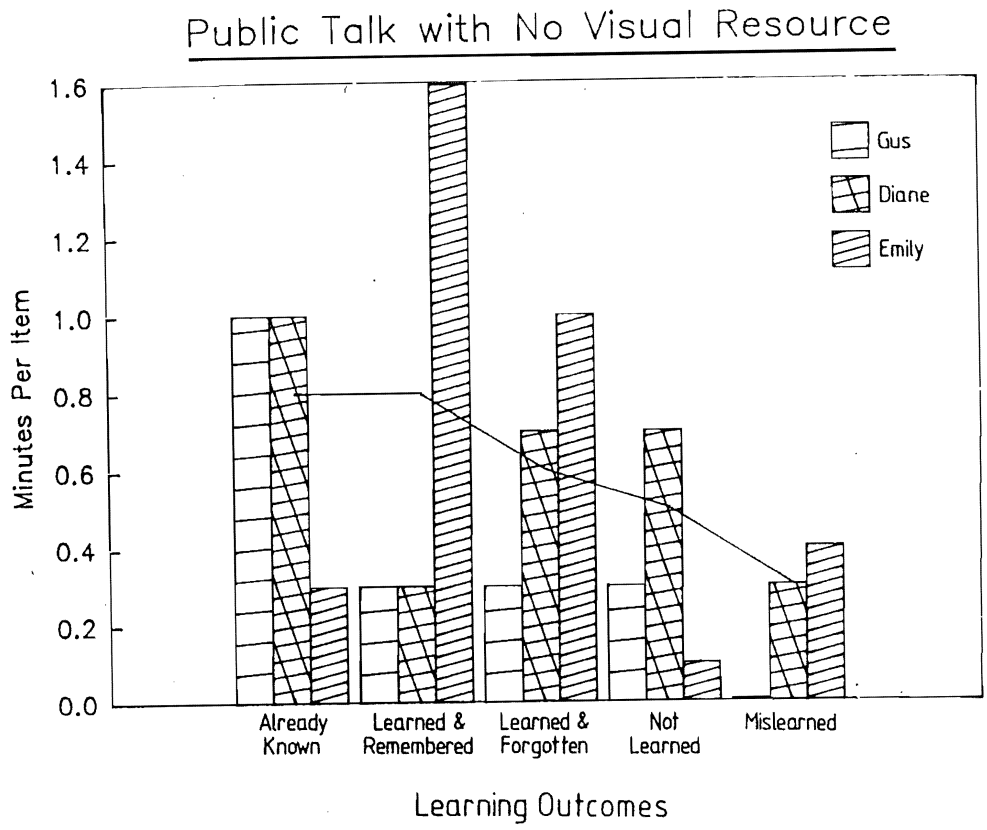


Figure 21

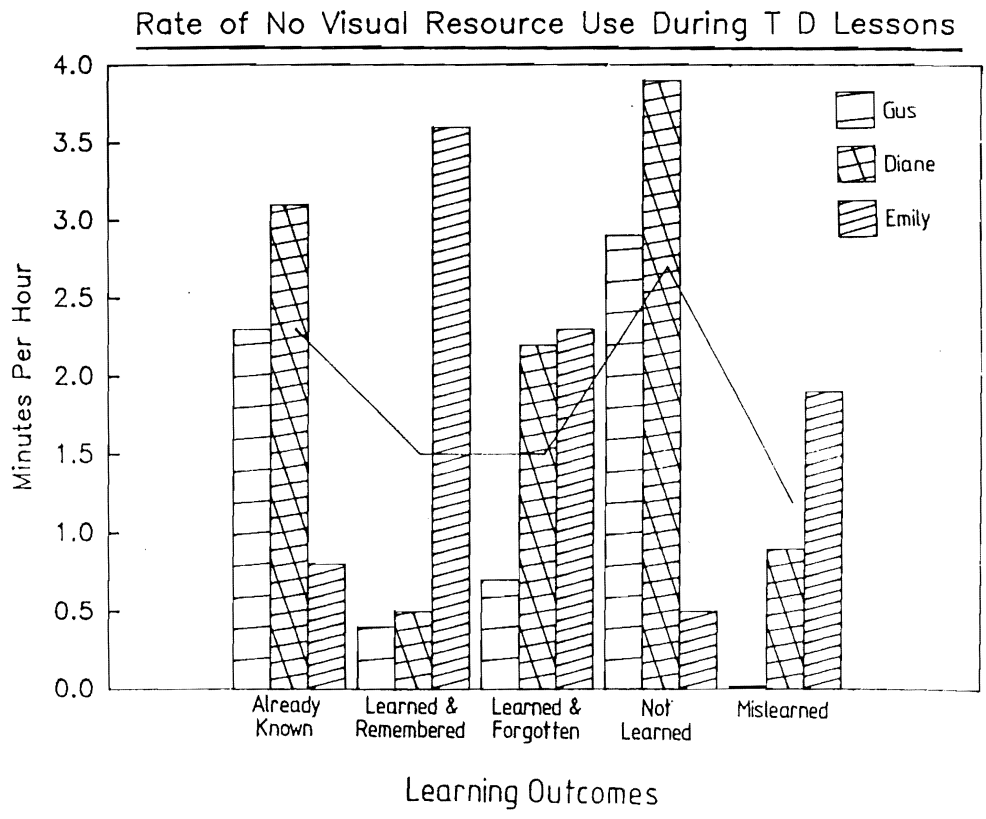


Table 20

Mean Minutes (Total Time) of Opportunity to Attend to Visual Resources During Teacher Directed Lessons: Means Calculated Only for Items Taught During Teacher Directed Lessons (93.3% of Items)

Pupils	No Res	BB	Demo	Book	Picture	Chart
			Resource			
			Items Already Known			
Gus	1.0	9.8	1.3	3.8	1.1	0.9
Diane	1.0	11.2	2.0	2.5	1.2	0.5
Emily	0.3	11.3	3.0	2.1	1.3	0.6
Mean	0.8	10.6	2.0	2.9	1.2	0.7
			Items Learned and Remembered			
Gus	0.3	17.9	2.9	5.3	3.3	2.2
Diane	0.3	13.5	4.5	3.8	2.7	2.8
Emily	1.6	11.9	2.2	3.9	1.9	1.4
Mean	0.8	14.2	3.1	4.3	2.5	2.3
			Items Learned and Forgotten			
Gus	0.3	12.1	2.2	6.7	3.9	0.7
Diane	0.7	4.5	2.7	4.7	4.2	0.8
Emily	1.0	10.4	2.7	2.7	4.1	1.8
Mean	0.6	9.7	1.8	5.0	4.0	1.1
			Items Not Learned			
Gus	0.4	2.9	0.0	2.7	0.3	0.2
Diane	0.7	6.1	0.1	1.5	0.8	1.2
Emily	0.1	6.7	0.0	1.5	0.5	0.3
Mean	0.4	5.7	0.0	1.7	0.6	0.7
			Mislearned			
Gus	0.0	1.0	0.0	0.0	0.0	0.0
Diane	0.3	9.9	2.1	4.0	2.0	0.1
Emily	0.4	5.5	0.1	2.7	1.5	0.2
Mean	0.3	7.2	1.0	3.1	1.6	0.1

which did not include visual resources were more likely to be occasions upon which they did not learn. The results for Gus and Diane were, however, inconsistent across the three data sets, and for Emily they were barely consistent (r = 0.49).

Other evidence indicated that visual resources were less significant for Emily than for Gus and Diane. During the interviews both Gus and Diane remembered being shown things by T and both spoke of having 'pictures in their minds':

Gus We learned what it looked like before and after.

and with reference to a chart:

Gus He showed us....

The interview data indicated that Diane frequently seemed to be using visual images to enable her to respond to the test questions:

Diane I can see it in my mind on the blackboard.

And, with reference to the hydrologic chart:

Diane Oh, I've got the picture in my mind but I can't sort of say it.

Emily did not appear to use memories of visual resources in the same way. She remembered doing charts but she did not remember seeing them. With respect to blackboard work or pictures she appeared to remember the physical act of T writing or other contextual clues

Table 21

Rate of Opportunity to Attend to Resources During Teacher-Directed Lessons in Relation to Pupil Learning

Minutes Per Hour

Pupils	No Res	BB	Demo	Book	Pict	Chart
			Resource			
			Items Already Known			
Gus	2.3	28.3	3.7	10.9	3.1	2.5
Diane	3.1	34.0	6.0	7.7	3.7	1.3
Emily	0.8	34.3	9.0	6.4	4.0	1.8
Mean	2.3	31.6	5.8	8.7	3.5	2.0
			Items Learned and Remembered			
Gus	0.4	31.6	5.1	9.3	5.8	4.0
Diane	0.5	26.5	8.8	7.4	5.3	5.5
Emily	3.6	28.1	5.1	9.1	4.4	3.2
Mean	1.5	28.9	6.2	8.7	5.2	4.2
			Items Learned and Forgotten			
Gus	0.7	26.5	4.9	14.8	8.5	1.7
Diane	2.2	15.8	0.0	16.3	14.5	2.7
Emily	2.3	23.9	6.2	6.2	9.4	4.2
Mean	1.5	23.7	4.5	12.1	9.8	2.6
			Items Not Learned			
Gus	2.9	25.4	0.0	23.2	2.2	1.5
Diane	3.9	32.9	0.2	8.0	4.1	6.2
Emily	0.5	40.4	0.0	8.9	3.1	1.8
Mean	2.7	34.6	0.1	10.1	3.5	4.2
			Items Mislearned			
Gus	0.0	60.0	0.0	0.0	0.0	0.0
Diane	0.9	28.9	6.1	11.7	5.7	0.2
Emily	1.9	28.0	0.4	13.6	7.4	0.8
Mean	1.2	28.7	4.0	12.4	6.3	0.4

Figure 22

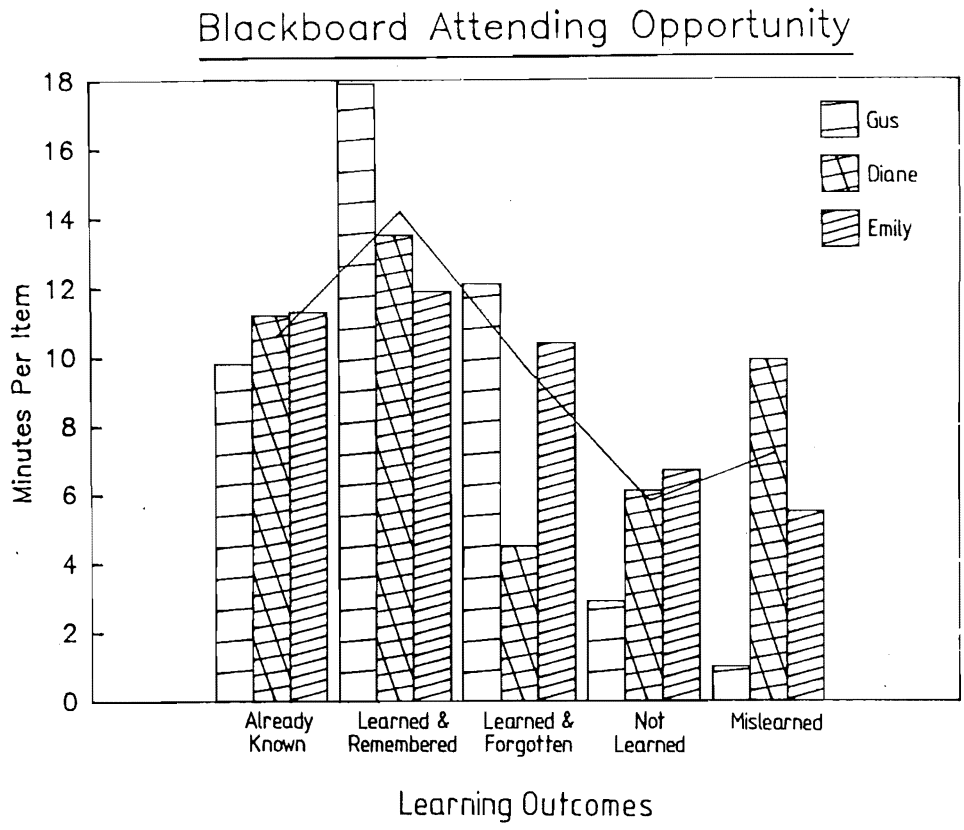
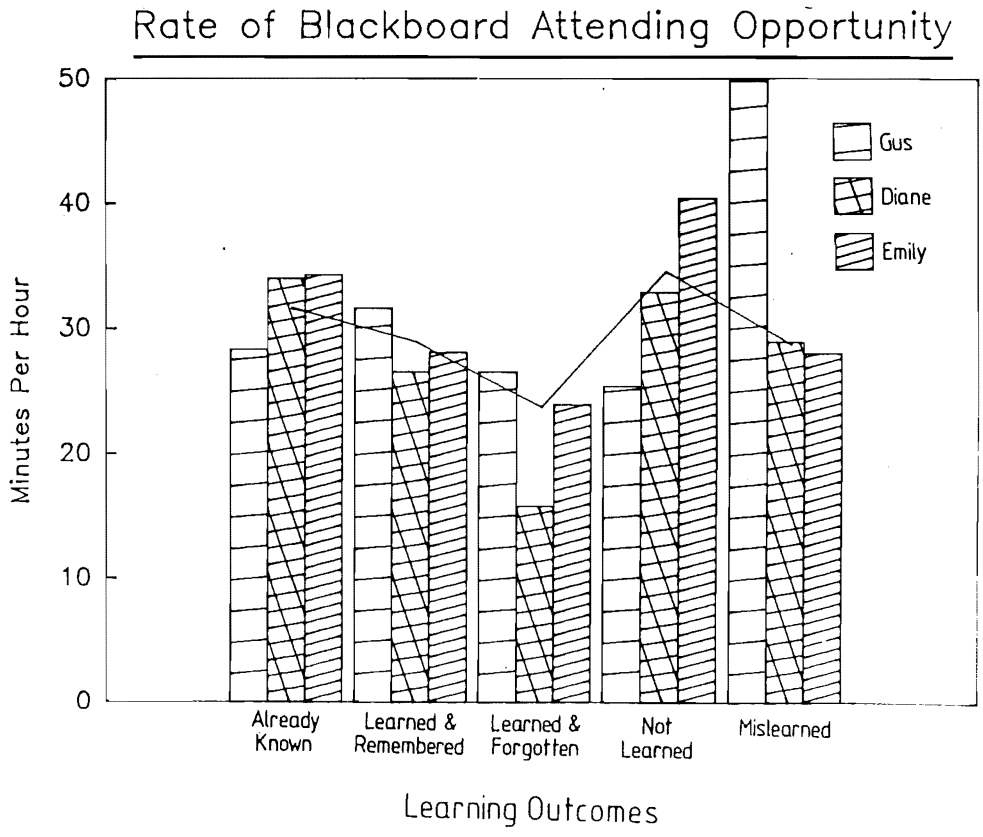


Figure 23



but not the visual product:

Emily He did it on the blackboard
on a Tuesday.

In summary, the slightly higher rates of occasions with no visual resources associated with the content of items which were not learned suggests there may be a relationship between the use of some visual resource and learning. The consistency of the surprising result that more public talk which was not complemented by visual aids was associated with content learned by Emily suggests that a pupil effect may have operated. It is difficult to establish whether such a pupil effect was operating in an important way however, because there was very little time when a visual resource of some kind was not used (97% of teacher-directed lesson time involved the use of visual resources) and the results for the three pupils are marginally consistent across the three prediction sets.

9.3.2 Blackboard

T characteristically used the blackboard to emphasize key words and draw rapid diagrams illustrating ongoing verbal content. In Figure 22 it can be seen that the highest blackboard use was associated with content learned and remembered by all three pupils. Items already known and items learned and forgotten were associated with the next highest opportunity to attend to a blackboard and the least opportunity occurred for the content of items not learned.

The average number of minutes of blackboard attending opportunity relevant to the content of items learned and remembered was 14.7 minutes in contrast with 9.7 minutes relevant to the content of items learned and forgotten and 5.7 minutes relevant to the content of items which were not learned. See Table 20. As can be seen in Table 19 the pattern of results for blackboard attending opportunity in relation to pupil learning was consistent across the three data sets for all three pupils. The overall reliability coefficient was r = 0.86.

Although the highest average minutes of blackboard attending opportunity were related to pupil learning, the highest overall rate of blackboard attending opportunity occurred for the content of items not learned. See Table 21 and Figure 22. This result was consistent across the three data sets for Diane and Emily (r = 0.68, and r = 0.93) but inconsistent for Gus. The inconsistent result for Gus was largely influenced by the fact that for some content which he failed to learn the little time spent involved continuous blackboard attending opportunity while for other content which he failed to learn the little time spent involved no such opportunity.

In summary, too much teacher blackboard usage at a time relative to other resource usage was generally unproductive but total pupil opportunity to attend to content on a blackboard over different occasions was related to long-term pupil learning outcomes.

These results suggest that the opportunity to attend to a blackboard was related to learning through its association with the increase in time spent on the content of learned items. When time is held constant the rate of blackboard usage was not associated with learning.

However, the length of blackboard attending opportunity was associated with learning and the way this association occurred is worth exploring.

T used the blackboard in varying ways. Sometimes T drew diagrams to illustrate concepts such as river or glacial erosion. More often T used the blackboard to highlight key vocabulary.

During the interviews Gus reported remembering T underlining key words on a blackboard and drawing a diagram of 100 squares to illustrate the concept of one percent. Diane reported remembering that 'he wrote' words on the blackboard in relation to specific content and Emily frequently reported remembering that T 'did it on the blackboard' and once reported that 'he drew it on the blackboard'. The findings reported in section 9.3.4 and Chapter 12 on pupil opportunity to attend to charts and diagrams suggest that diagrams did facilitate learning more effectively than written material.

Another variable which may be important in interpreting these findings is pupil reading ability. Both Diane and Emily explained that sometimes they did not understand words on the blackboard; particularly in relation to language activities. Gus was the most competent reader of the three pupils but even he explained that sometimes he did not understand vocabulary recorded on the blackboard:

> Well, the words that he gives you -
> sometimes you don't really know
> what they are and you don't know
> what they mean...

If Gus was having difficulty reading some of the words then Diane and Emily were likely to have experienced more difficulty. Thus, Gus's higher reading achievement levels may have facilitated the relatively stronger relationship between his learning and blackboard attending opportunity (Figures 22 and 23).

9.3.3 Books

The analysis of general use of books included all use of books during teacher-directed lessons. This category included situations where T read from a book, where T discussed headings or illustrations from a book, where both T and pupils took part in a shared reading of a blown-up book, and where all pupils had a copy of a story or article in a guided silent reading lesson. On one occasion Diane brought, from her local library, a book about New Zealand animals which T used as the focus of a teacher-directed lesson. He discussed each illustration with the class. Gus's interview responses revealed that he had a strong memory for the story of 'The Lorax' by Dr Seuss which was read by T:

Gus ...and the little boy who gives
him some money and he pulls it
right up and he starts telling
him a story. And he goes to this
place where there's a lot of trees...

As can be seen in Figure 24 pupil opportunity to attend to books was higher for content which was learned (remembered and forgotten) than for content not learned or mislearned. For Gus and Diane the most opportunity to attend to books occurred in relation to content which was learned and forgotten. The least opportunity

Figure 24

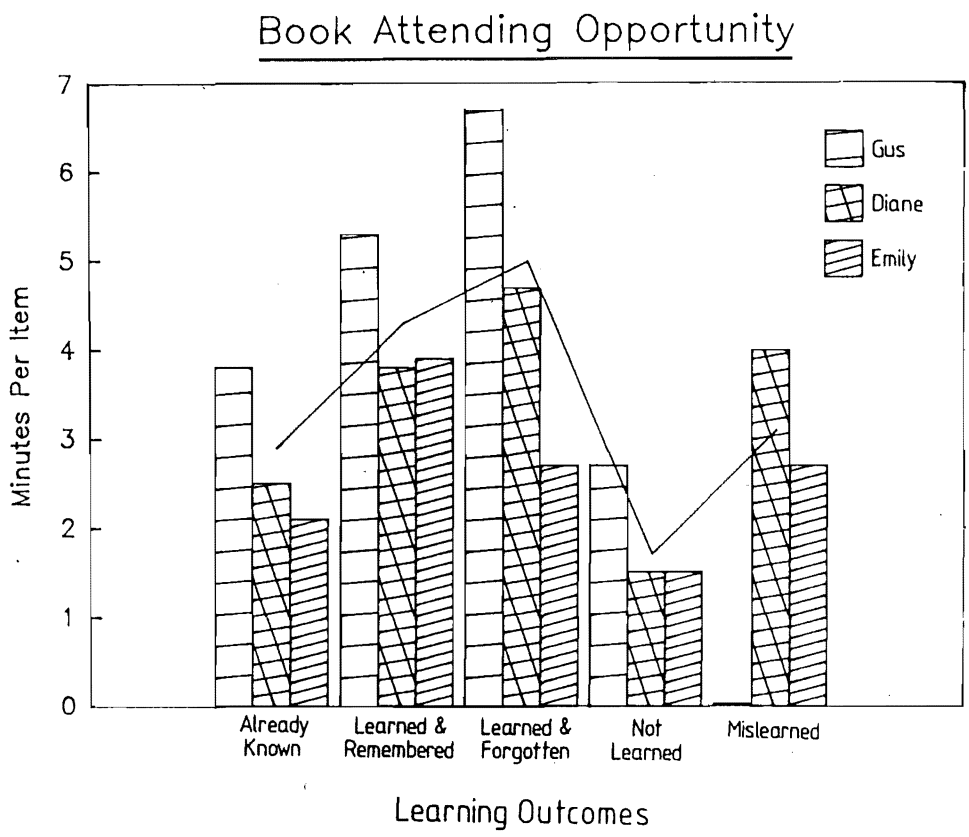
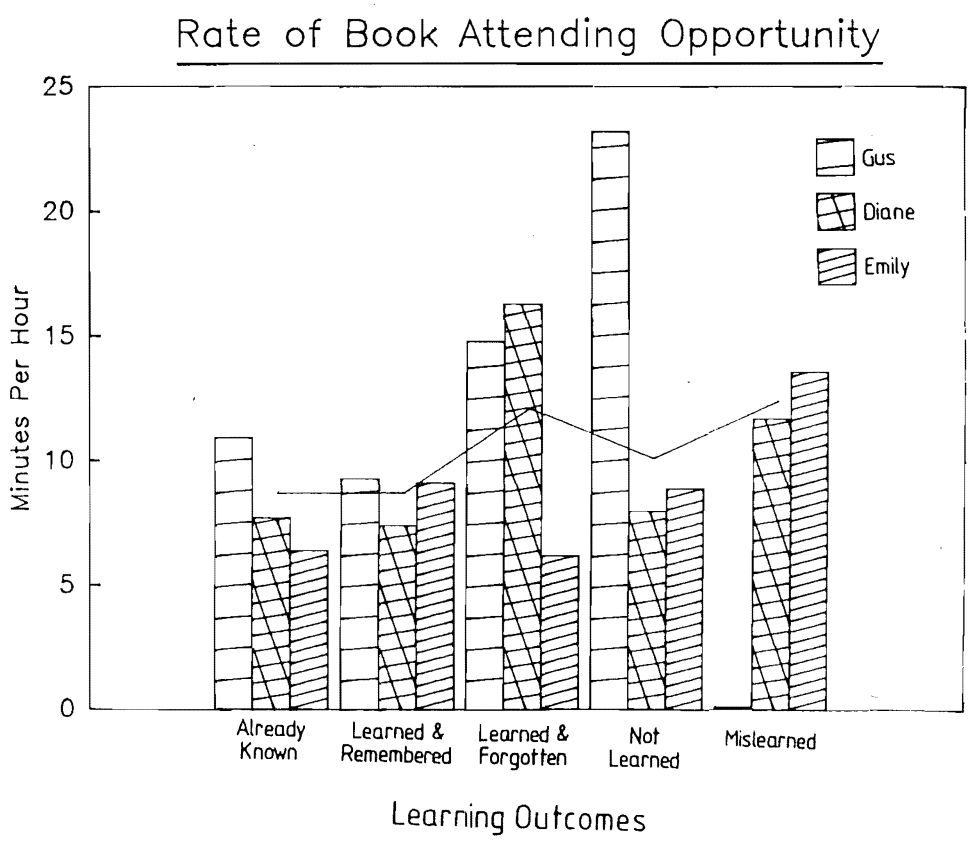


Figure 25



to attend to books was associated with content which was not learned. It can be seen in Table 18 that books were the second most frequent resource used. However, they were used for less than a third of the time that the blackboard was used to illustrate content which was learned and remembered. Gus had more opportunity to attend to or make use of relevant content in books than Diane or Emily in all categories except for the one item he mislearned. This greater opportunity occurred because he was in the high achievers' reading group where considerably more unit content was covered than in the average achievers' reading group to which Diane and Emily belonged. Emily had the least opportunity to attend to relevant content in books during teacher-directed lessons.

As with blackboard attending opportunity when the opportunity to attend to books is expressed as rate per hour, the relationship disappears. As can be seen in Table 21 increased use of books as a resource relative to other resources was associated with failure to learn, forgetting or mislearning. None of the results for book attending opportunity were consistent across the three data sets for either actual opportunity or rate of opportunity.

In summary, the quantitative findings for general use of books indicate that when opportunity to attend to relevant content in a book occurred over a number of occasions that opportunity showed an inconsistent relationship with short-term learning outcomes for Gus and Diane and with long-term learning outcomes for Emily. The overall rate of opportunity to attend to books was about ten minutes per hour.

The interview data provided further insight into the relationship between use of books and pupil learning. Articles read and discussed during directed silent

reading lessons were remembered and referred to in the course of pupil responses. However, an article about the kokako which the teacher read to the children was entirely forgotten to the extent that all three children denied ever having heard the word, 'kokako'. T's reading of this article took up 20 minutes of class time.

T also used books as sources of relevant pictorial material. The congruence between the findings for both resources in relation to short-term learning suggests that pictures of phenomena unfamiliar to the pupils did not facilitate long-term learning.

As was apparent in Gus's account of 'The Lorax' reported earlier, the fictional stories and modern parables of the dangers of pollution such as 'Lester and Clyde', 'The Sknuks' and 'The Lorax' were remembered in great detail by all three pupils who had participated in shared reading lessons using these stories. However, these stories were predominantly relevant to the attitudinal items in the test.

It seems that pupil memory for books used was directly related to the degree of pupil involvement in those books and pupil learning associated with the use of books was inconsistent and mainly short-term learning.

9.3.4 Pictures

Pictures used during the unit were predominantly old calendar and magazine pictures illustrating sea and river erosion and erosion in mountainous environments. Photographs of three of the pictures used by T are shown in Figures 26, 27, and 28. T would typically direct pupil attention to a picture and ask the

Figure 26

A Photograph of a Resource Picture used by T to Illustrate Slips and Sea Erosion.

Figure 27

A Photograph of a Resource Picture used by T to Illustrate Glacial Erosion.

Figure 28

A Photograph of a Resource Picture used by T to Illustrate River Erosion in a Mountain Stream.

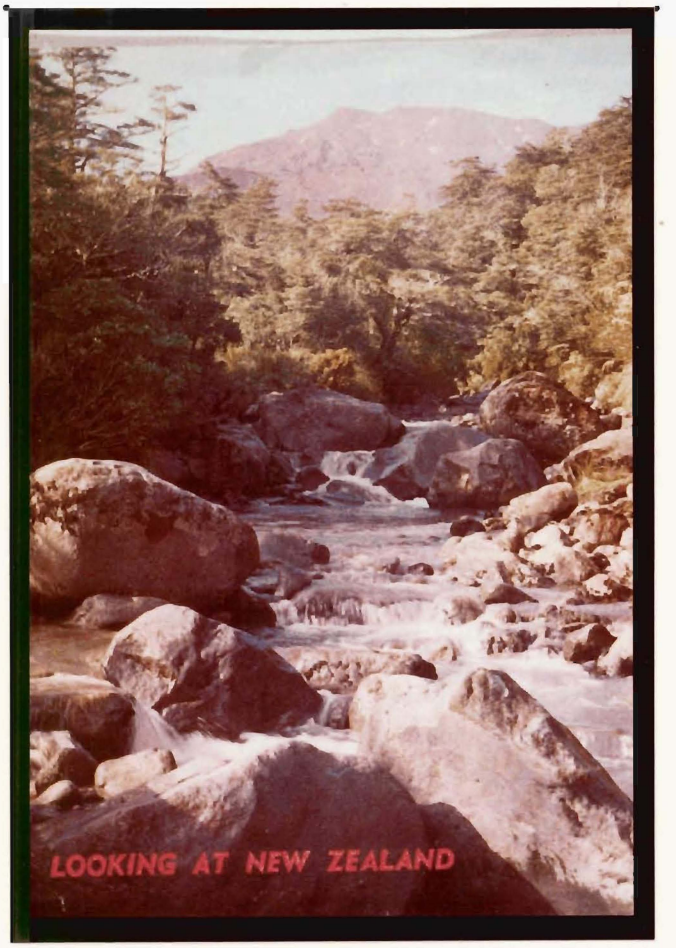


Figure 29

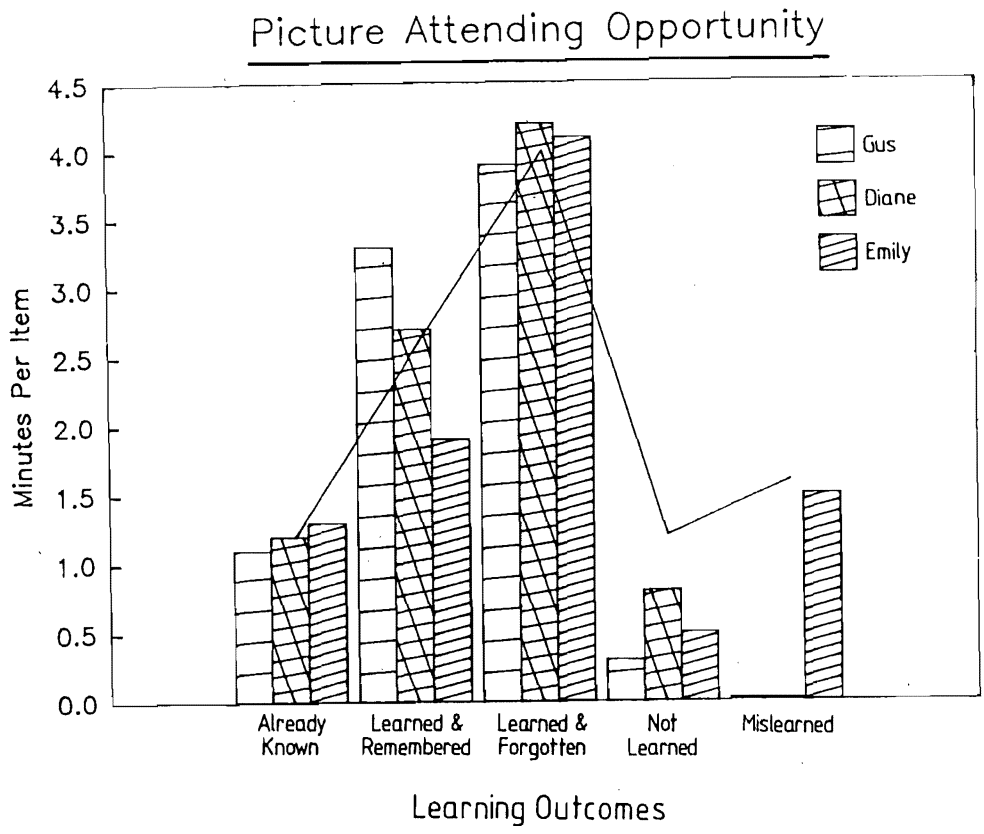
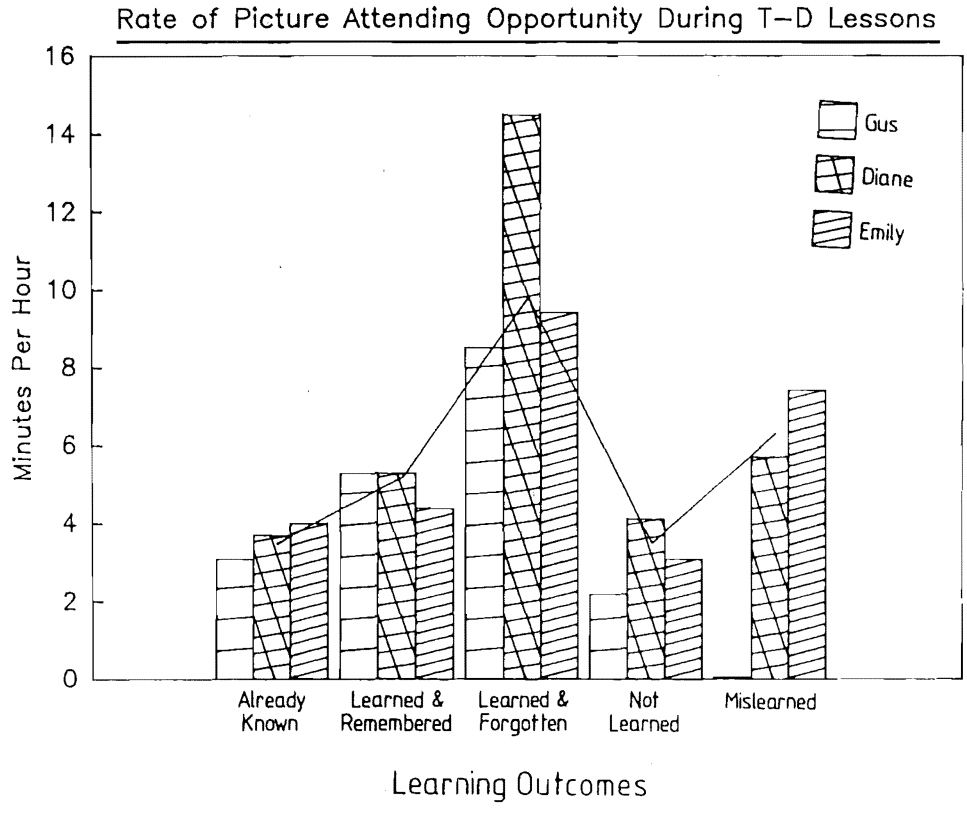


Figure 30



children what they could see. Subsequently both T and pupils would refer to specific pictures in the course of class discussion. The following discussion occurred in relation to the picture of glacial erosion shown in Figure 26:

Pupil You know in that picture up there - what do you call those big things?

T Glaciers.

Pupil You know, you said there's water flowing under them... Is that a river up there? Is that the water coming down? Why would that boy and girl be standing in the middle?

As can be seen in Figure 29 actual pupil opportunity to attend to pictures was highest for items learned and forgotten for all three pupils, second highest for items learned and remembered for all three pupils, and least for items not learned. The average number of minutes of opportunity to attend to pictures during teacher-directed lessons was 2.5 minutes of content learned and remembered and 4.0 minutes for content learned and forgotten (see Table 20). These results were generally consistent across all three data sets with an overall reliability coefficient of r = 0.82.

The results for rate of pupil opportunity to attend to relevant content in picture form were similar to the frequency results, with the opportunity for items learned and forgotten about twice that for items learned and remembered. The overall reliability coefficient for rate was r = 0.57.

In summary pupil opportunity to attend to relevant content in pictures was strongly and consistently associated with short-term learning outcomes.

One year after the unit Diane reported, of the pictures used, that she could 'not remember what they were like'. Gus said that he could not remember 'all that much about them' and Emily could remember where they were on the wall but she could not remember, in any detail, what they showed. Thus the pupil memories are congruent with the quantitative findings.

T used pictures to illustrate things that were out of the pupils' experience such as glaciers, pancake rock formations, tahr, chamois, endangered species of many kinds and so on. The prediction results pointed to the critical element of direct pupil experience in relation to long-term learning. This pattern of results showing the failure of picture attending opportunity to facilitate long-term pupil learning is consistent with the apparent importance of direct pupil experience of concepts.

Diane's interview responses provide evidence that her concepts of some animals were quite different from the real beasts which she confronted on the class trip to the lion park. Also her concept of a hill or mountain (which she had never actually experienced) is confused in the interviews and shown to be clearly inadequate in her characterization of a mountain stream shown in Figure 66.

Gus was one of the few children in T's class who was able to provide an actual example of his own experience of erosion in the environment and his account of how he knew of that example is important here because he explains how he interpreted a picture using that experience:

> Well, once when we were driving through there the hills were all tumbled. There was a great big slip down the side of the road and when we were doing erosion and that, someone brought a clip out of the paper, a picture of it, and it was just how I remembered it...

9.3.5 Charts

The main chart used during the unit was a detailed chart of the hydrologic cycle which was relevant to four pollution items. A photograph of this teacher-made chart of the hydrologic cycle is shown in Figure 31. Two charts depicting endangered animals in their environments were also used.

As can be seen in Figure 32 relationships between opportunity to attend to charts and pupil learning differed for each pupil but the overall pattern of opportunity to attend to charts related to pupil learning. Charts were used in relation to relatively few items which suggests the relationship may be important. The inconsistency between data sets apparent in the reliability coefficients shown in Table 19 reflects the uneven usage of charts in relation to the content of few items.

As can be seen in Figure 33 the rate of opportunity to attend to charts was higher for content learned by Gus and Emily but higher for content not learned by Diane. However, these results were also inconsistent across the three data sets ($r = 0.0$).

Figure 31

A Photograph of the Resource Chart made by T to show the Hydrologic Cycle.

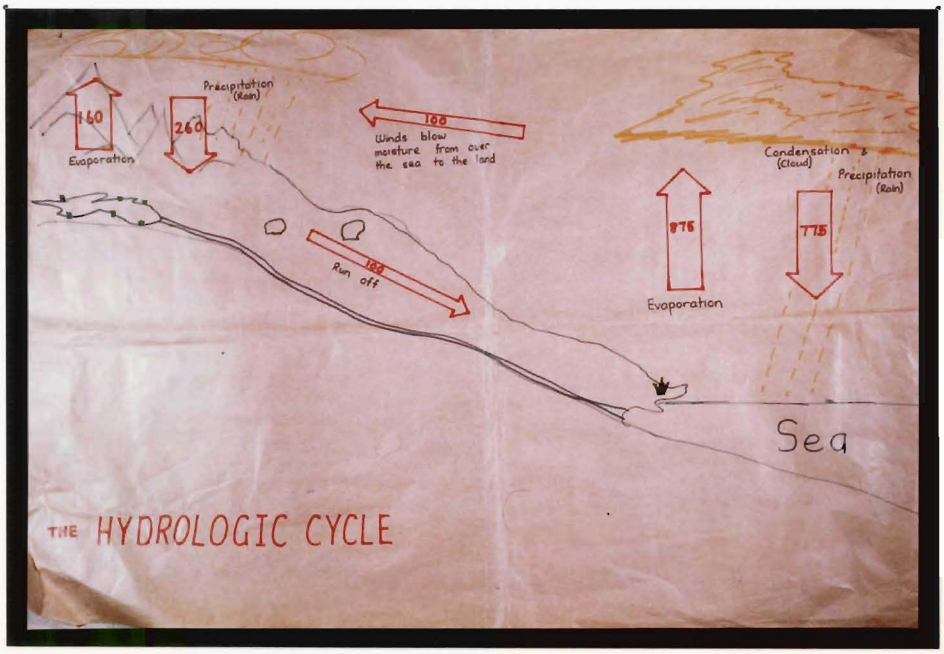


Figure 32

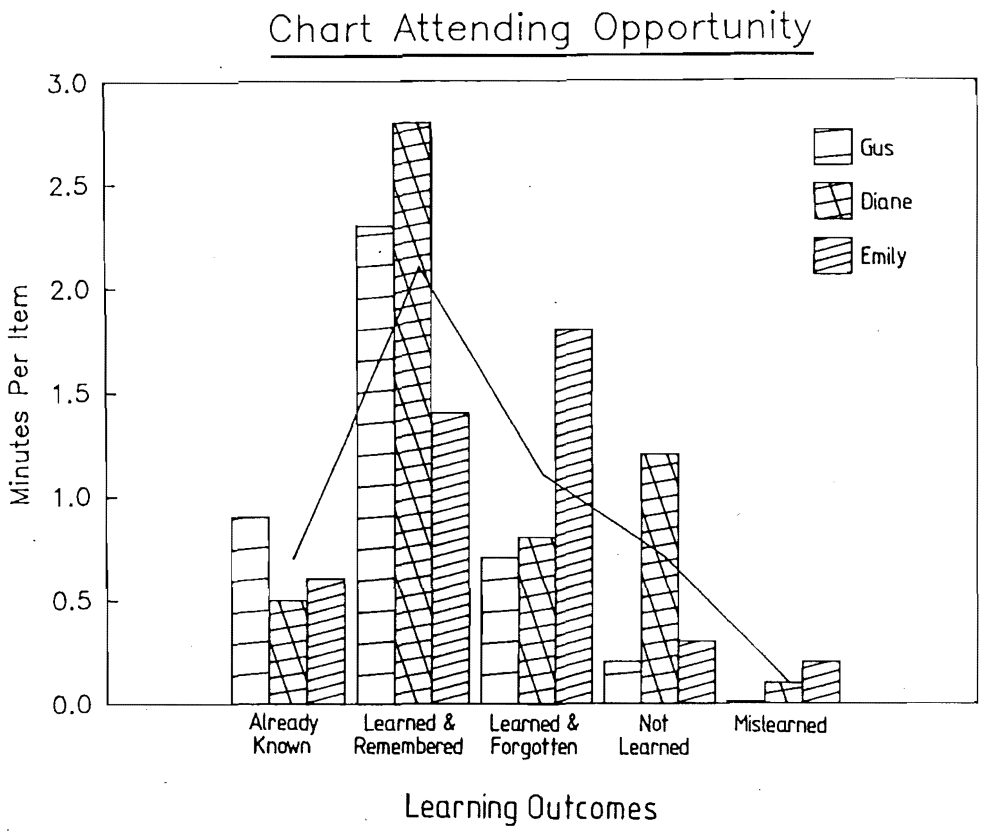
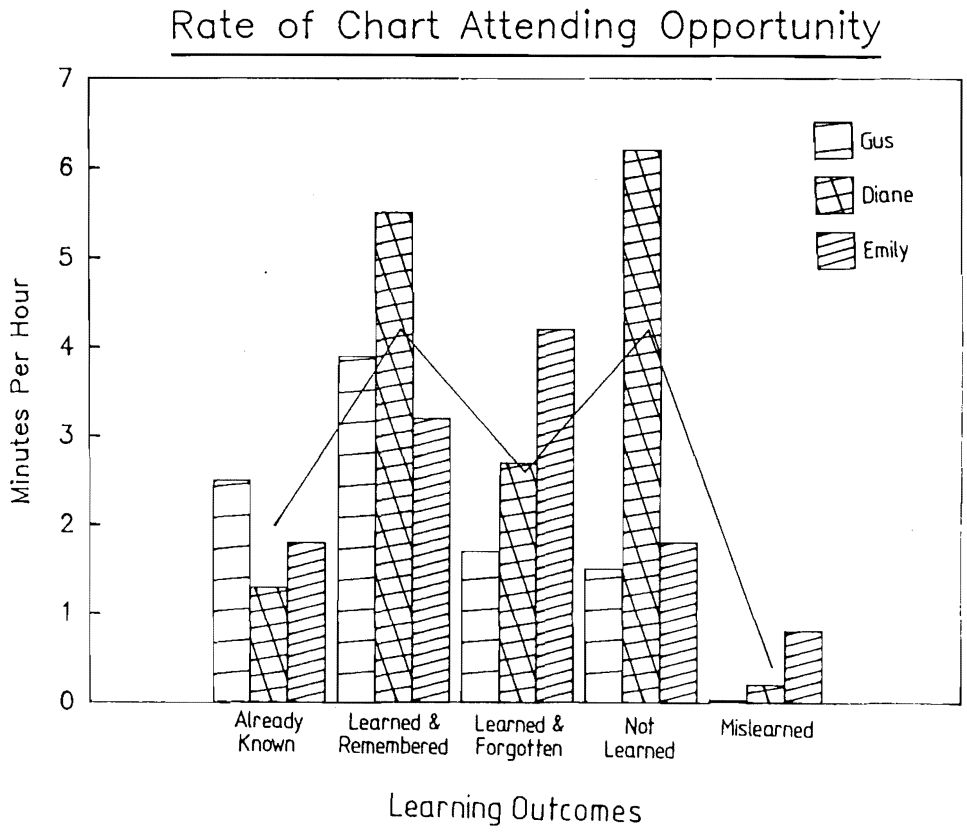


Figure 33



The interview data suggests that chart attending opportunity may have been more significant than these results indicate. All three children were able to give vivid descriptions of the hydrologic chart (shown in Figure 31) during the interviews.

Gus ...and it had the clouds and arrows pointing up to the clouds and the clouds blown over the land by the wind...

Diane ...and the rains came down into the rivers and then back into the sea, I think. And then it all starts over again...

Emily ...it goes up in the clouds and then it comes down on the land...

I Did he just write the words up?

Emily No, he drew the picture.

The discussion in Chapter 12 makes it clear that because charts were used in relation to relatively few items the results discussed above do not adequately represent the facilitative effect of chart attending opportunity. An analysis of content which was learned in spite of less time spent shows charts and diagrams were instrumental in facilitating pupil learning of this content.

9.3.6 Demonstrations

Demonstrations were used in relation to 13 erosion items. T used a vacuum cleaner and water to demonstrate the process of wind and water erosion on sand, unvegetated soil and vegetated soil. These demonstrations were referred to as 'experiments' by both T and the pupils.

It can be seen in Figures 34 and 35 that pupil opportunity to attend to demonstrations was strongly related to learning both in total opportunity and rate per hour. Virtually all content taught in a demonstration context was learned. Diane failed to learn one item about the definition of vegetation, the content of which was briefly mentioned in the course of the demonstration with reference to a turf of grass.

The results for demonstration attending opportunity were consistent across all three data sets for both frequencies and rates ($r = 0.82$ and $r = -0.63$). These results suggest a critical link between pupil opportunity to attend to concrete demonstrations and learning in contrast with the weaker relationships between pupil learning and pupil opportunity to attend to two-dimensional resources. Observer, teacher, and pupil perceptions are congruent with these quantitative findings.

One year after the unit the pupil memories of the demonstrations were very clear:

Gus I think he had dry dirt with sand
and he turned the vacuum cleaner
on so it would blow and it blew
the dirt away slowly - I mean all
the sand or whatever and it slowly

Figure 34

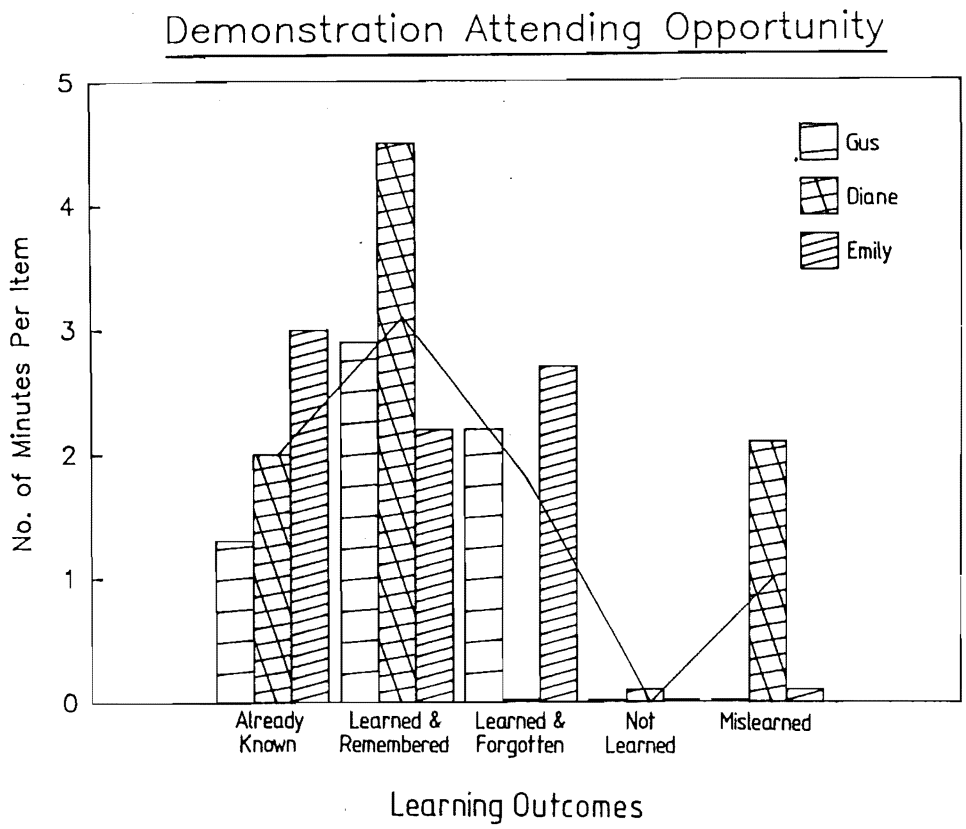
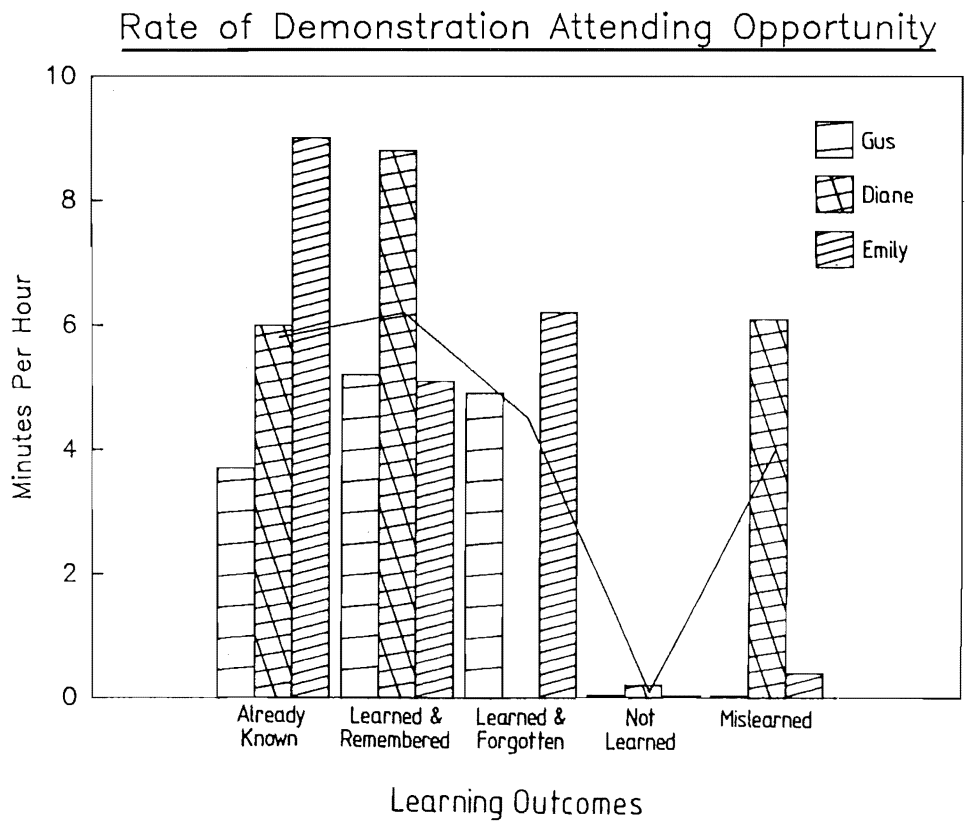


Figure 35



just got down so it was all spread all over the place. And he did another one with I think, wet dirt and he was blowing it and instead of it all blowing away very quickly it slowly blew away.

And he did one with just water and he had water in it and sand and he was tipping the bottom... and it was slowly getting worn down so it ended flat.

I Why did he do that experiment? What was he trying to show people?

Gus The wind and um eroding the mountains and the sea eroding the beaches and that... It taught us what it's like on a big grassy hill and on the beach and things when the wind's blowing.

Diane

I remember we had the thing with sand in it and water and we moved it round - I think it's the sea. I can remember with the vacuum cleaner how you do it and we turned it on and it flew out and that.

I Why did Mr H do all that?

Diane

> It's sort of an experiment. Um... instead of showing the real thing it's sort of showing it except in a different way.

Emily's responses indicated that she had become confused by the usual function of a vacuum cleaner, nevertheless she remembered the episode:

Emily

> Well, he had sand and he sucked the sand up with the vacuum cleaner... he did it with water...

T remarked 'that he was very pleased with the experiment lesson (demonstration)' and that he wished that he had done it earlier. All three observers noted, at the time, that the demonstration lesson seemed to be a very effective lesson and the high point of the erosion sub-topic.

9.3.7 Teacher-Directed Mime

Mime lessons involved T giving verbal instructions to the class who were encouraged to express concepts and processes by silently acting out these ideas. For example, the pupils mimed the process of water freezing into ice and expanding:

Figure 36

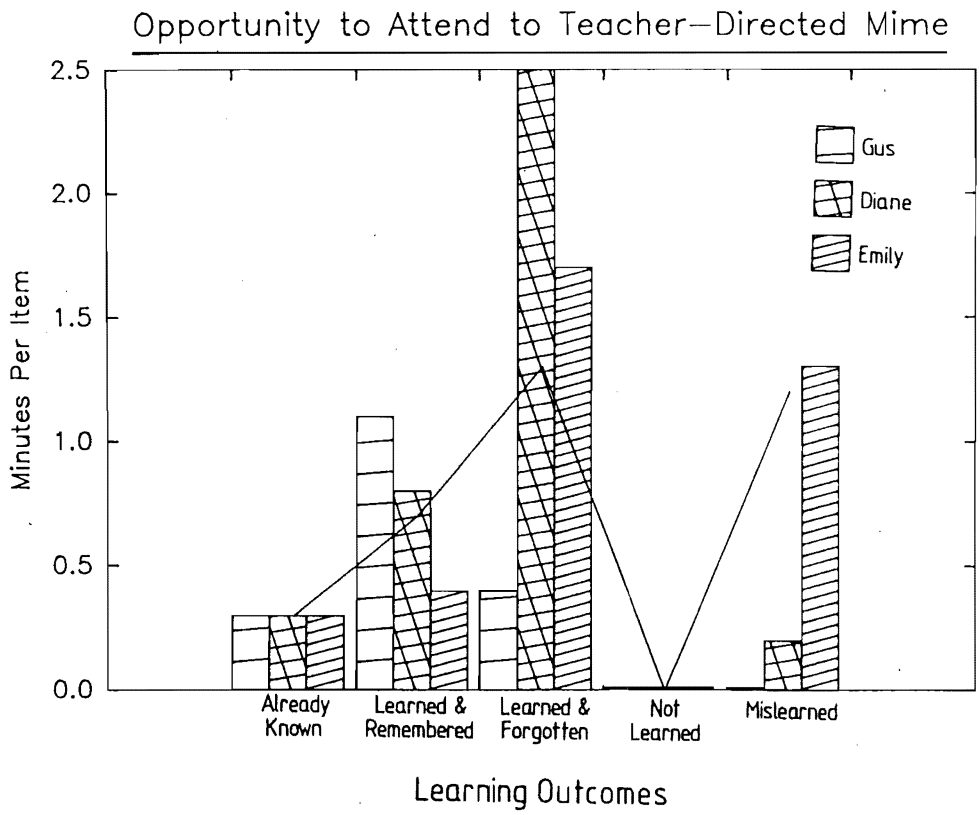
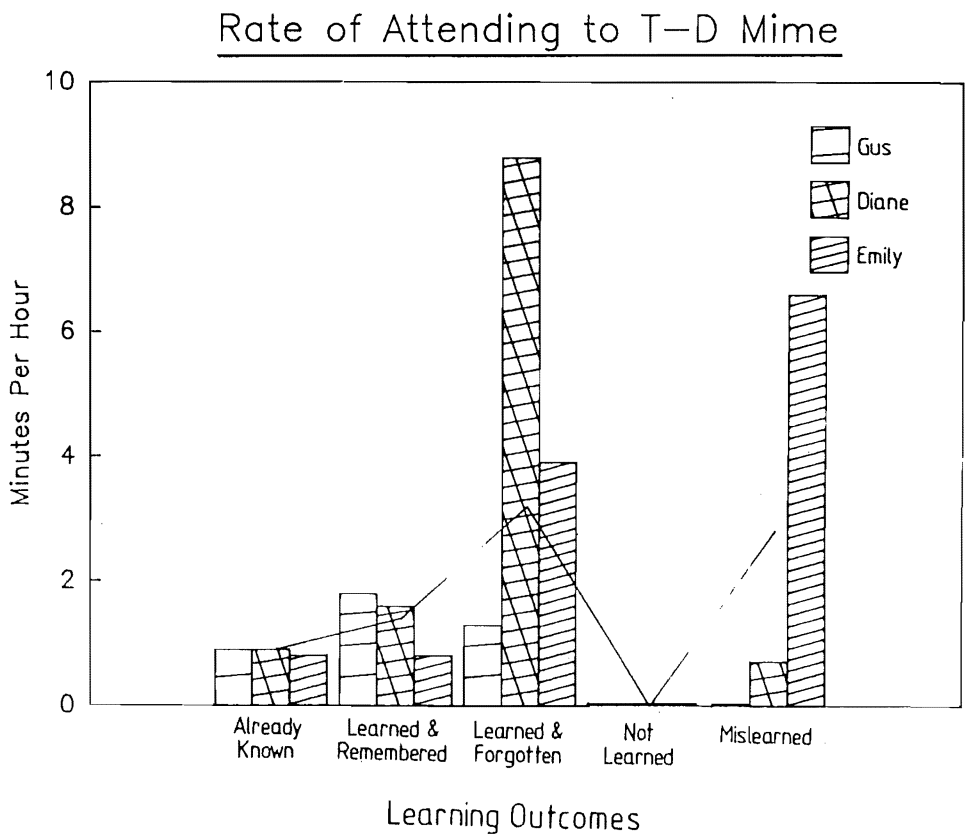


Figure 37



T Imagine you are a drop of water. Right-Oh! Gradually the temperature is dropping until you get solid and then you expand as you freeze. Let's see you expand it with your legs and your elbows. Expand it!

The results shown in Figures 36 and 37 show that both frequency and rate of opportunity to attend to teacher-directed mime was associated with learning, - and in particular, with short-term learning for Diane and Emily.

These results are interesting because they are more congruent with the results for picture and book attending opportunity than the results for demonstration attending opportunity. Both T and the researcher incorrectly predicted that pupil involvement in teacher-directed mime would facilitate long-term learning because these lessons involved the pupils 'demonstrating' the desired concepts. Two of the observers noted that these mime sessions appeared to have a powerful effect on the children:

Gus - concentrating intensely -very controlled response to creative movement

Emily - really responding to teacher in this... responded very well to this activity type lesson with much less distraction than noted on my previous observation of her. ...being a cliff this time

> -showing a lot of response
> to these activities.

It seems that the children were involved in the lessons. A year later their interview responses confirmed this interpretation. However, involvement in mime did not facilitate remembering when pupils were unclear about the process which they were miming. For example, Diane remembered the mime in which she participated as a rock moving down a river:

> ...we were in the Flea Pit and
> we were all pretending we were
> rocks and rolling around and
> that. Pretending we were
> banging into each other.

However, she did not learn the concept that the rocks, which are initially jagged and sharp, become rounder and smaller as they move down the stream. Her account of this process in her individual task work shown in Figure 66 shows that her inadequate conception of this process was prevalent in all her work. This was not changed by the mime opportunity.

9.3.8 Summary of Results for Opportunity to Attend to Visual Resources

Visual resources were almost continually employed during teacher-directed lessons. On average, every hour of teacher-directed time spent on content which was learned and remembered involved about half an hour of blackboard attending opportunity. All other visual resources were used at a rate of less than ten minutes

minutes per hour during this time.

Teacher demonstrations were the most effective resource opportunity. Charts were also effective in facilitating pupil learning but some content which occurred in a chart was not learned.

The blackboard was an effective resource when used as well as, rather than instead of, other resources to teach tested content. Pupil opportunity to attend to pictures was consistently related to short-term learning as was pupil opportunity to attend to teacher-directed mime. Pupil opportunity to attend to books was inconsistently related to pupil learning.

9.4 PATTERNS OF NON-PASSIVE PUPIL BEHAVIOUR DURING TEACHER-DIRECTED LESSONS

The patterns of occurrence of observable pupil behaviours during teacher-directed lessons provide information about the pupil response to the lessons. Whereas the opportunity to attend to talk and resources was controlled by the teacher, non-passive pupil behaviours during teacher-directed lessons were predominantly voluntary pupil responses which occurred during every kind of teacher-directed lesson.

Eight pupil behaviours which occurred during the opportunity to attend during teacher-directed lessons are discussed in this section: public individual interactions with T, hand raises, talking to self, participations in chorus responses, informal mime,'fiddling' and verbal and non-verbal interactions with peers. Interactions with T, hand raises and chorus responses were sometimes directly elicited by T.

Table 22

Mean Numbers of Non-Passive Pupil Behaviours During Teacher Directed Lessons in Relation to Pupil Learning: Means Calculated Only for Items Taught During Teacher Directed Lessons (93.3% of all Items)

	Behaviours							
Pupils	IntT	HanR	Talk	Chor	Mime	Fidd	IntP	Non
	Items Already Known							
Gus	5.8	5.6	4.1	1.5	2.2	5.7	10.5	1.9
Diane	1.9	3.4	1.2	0.6	0.7	4.8	2.2	1.2
Emily	1.4	3.4	0.1	0.9	0.3	4.4	2.7	1.4
Mean	3.5	4.3	2.1	1.1	1.3	5.1	5.9	1.6
	Items Learned and Remembered							
Gus	10.1	8.2	8.1	2.2	1.6	7.9	15.8	2.9
Diane	1.8	3.4	0.9	1.3	1.4	7.1	4.0	1.8
Emily	2.4	4.3	0.4	1.5	1.2	5.6	2.4	1.6
Mean	4.5	5.3	2.8	1.6	1.4	6.7	6.9	2.1
	Items Learned and Forgotten							
Gus	6.0	4.1	5.3	1.6	2.7	10.1	16.3	5.1
Diane	1.0	1.3	0.3	1.0	3.3	8.3	1.0	2.3
Emily	3.4	3.2	0.6	1.6	1.8	6.0	3.4	2.0
Mean	3.9	3.1	2.6	1.4	2.6	8.4	8.4	3.4
	Items Not Learned							
Gus	2.1	1.3	1.7	0.7	1.0	3.9	5.9	1.4
Diane	0.9	1.2	0.7	0.8	0.9	2.4	1.3	1.0
Emily	0.8	1.6	0.2	0.1	0.0	2.3	0.6	0.5
Mean	1.1	1.4	0.7	0.5	0.6	2.6	2.0	0.9
	Items Mislearned							
Gus	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
Diane	2.1	3.1	0.9	0.9	0.0	5.9	2.0	1.1
Emily	1.1	1.4	0.0	0.0	1.1	4.7	1.7	1.6
Mean	1.5	2.1	0.4	0.4	0.5	4.9	1.8	1.3

Table 23

Rate Per Hour of Non-Passive Pupil Behaviours During Teacher-Directed Lessons in Relation to Pupil Learning

Pupil	IntT	HanR	TalkS	Chor	Mime	Fidd	IntP	Non-V
				Behaviours				
				Items Already Known				
Gus	17.2	16.4	12.0	4.4	6.4	16.6	30.6	5.4
Diane	5.7	10.3	3.6	1.7	2.3	14.7	6.8	3.6
Emily	4.3	10.3	0.2	2.6	0.9	13.3	8.1	4.4
Mean	10.4	13.0	6.4	3.1	3.7	15.1	17.7	4.6
				Items Learned and Remembered				
Gus	17.9	13.9	13.8	3.7	3.2	13.6	27.4	5.1
Diane	3.5	6.6	1.8	2.5	2.7	13.9	7.8	3.5
Emily	5.6	10.6	0.9	3.5	2.7	13.2	5.7	3.9
Mean	9.4	10.6	5.8	3.3	2.9	13.5	14.2	4.2
				Items Learned and Forgotten				
Gus	13.2	9.1	11.6	3.5	6.0	22.3	35.7	11.3
Diane	3.5	4.4	0.9	3.5	11.4	28.9	3.5	7.9
Emily	7.8	7.3	1.4	3.7	4.1	13.8	7.8	4.6
Mean	9.7	7.7	6.3	3.5	6.3	20.6	20.7	8.4
				Items Not Learned				
Gus	7.3	8.7	11.6	7.3	4.3	33.3	42.0	11.6
Diane	5.1	6.6	3.6	4.2	4.8	12.9	7.2	5.4
Emily	4.6	9.7	1.0	0.5	0.0	13.7	3.6	3.1
Mean	5.2	7.9	3.7	3.3		15.6	10.0	5.4
				Items Mislearned				
Gus	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0
Diane	6.3	9.2	2.5	2.5	0.0	17.2	5.9	3.4
Emily	5.9	7.4	0.0	0.0	5.9	24.3	8.8	8.1
Mean	6.1	8.5	1.6	1.6	2.1	19.6	7.2	5.0

These eight categories include almost all observable non-passive pupil behaviours which occurred during teacher-directed lessons. Glancing behaviour was recorded but because of practical difficulties in recording changes in pupil glancing behaviour and inferential problems with the attribution of glance focus it was considered to be more useful to calculate pupil opportunity to attend to visual resources. Coughing behaviour was recorded but not analyzed and laughing behaviour was only analyzed where it constituted part of a peer interaction. Eyes closed behaviour occurred only for Diane on a number of occasions. The observers consistently attributed this behaviour to pupil fatigue. However, a later analysis revealed that Diane only closed her eyes when the teacher was discussing the slaughter of animals or the fatal pollution of their food and environment.

The analysis of the patterns of occurrence of these behaviours provides insights into pupil behaviours associated with learning and pupil behaviours which were not associated with learning during teacher-directed lessons. This analysis contrasts with traditional tallies of on- or off-task behaviour patterns.

9.4.1 Public Individual Interactions with T

This category includes teacher-elicited responses and call outs. Call outs were generally accepted by T as valid contributions to the discussion. Although teacher acceptance of call outs is not always considered to be desirable teaching practice, Cazden (1983) pointed out that teacher acceptance of pupil call outs is a prevalent teaching pattern at the 'instructional climax' of a lesson.

Figure 38

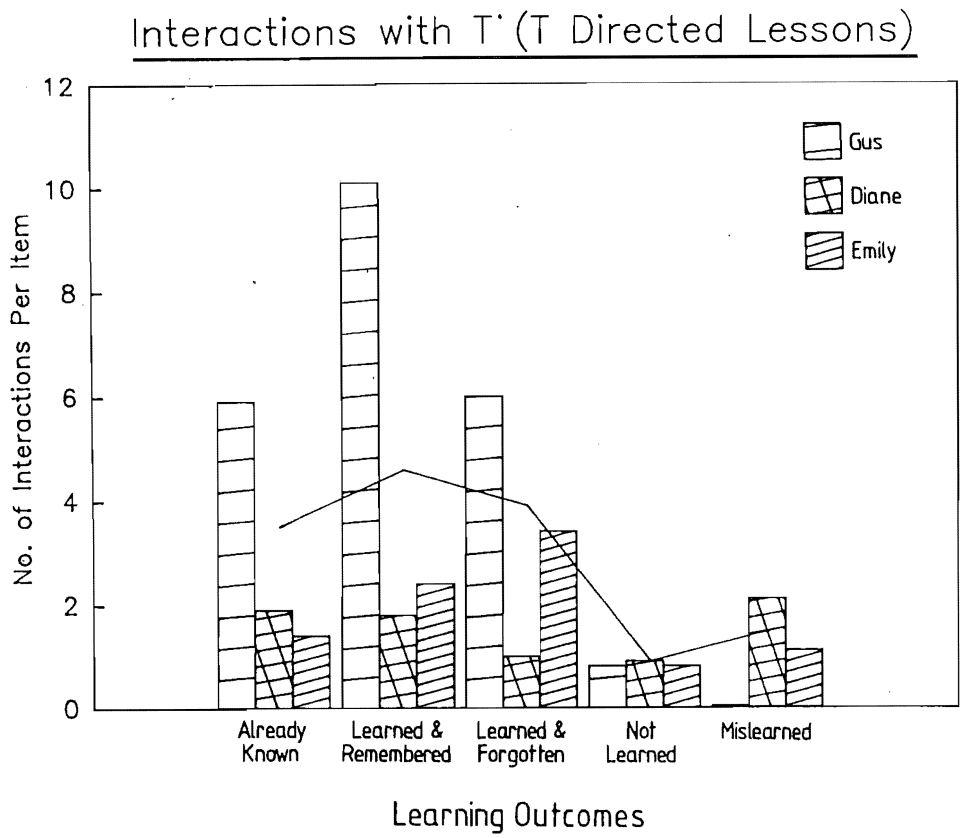
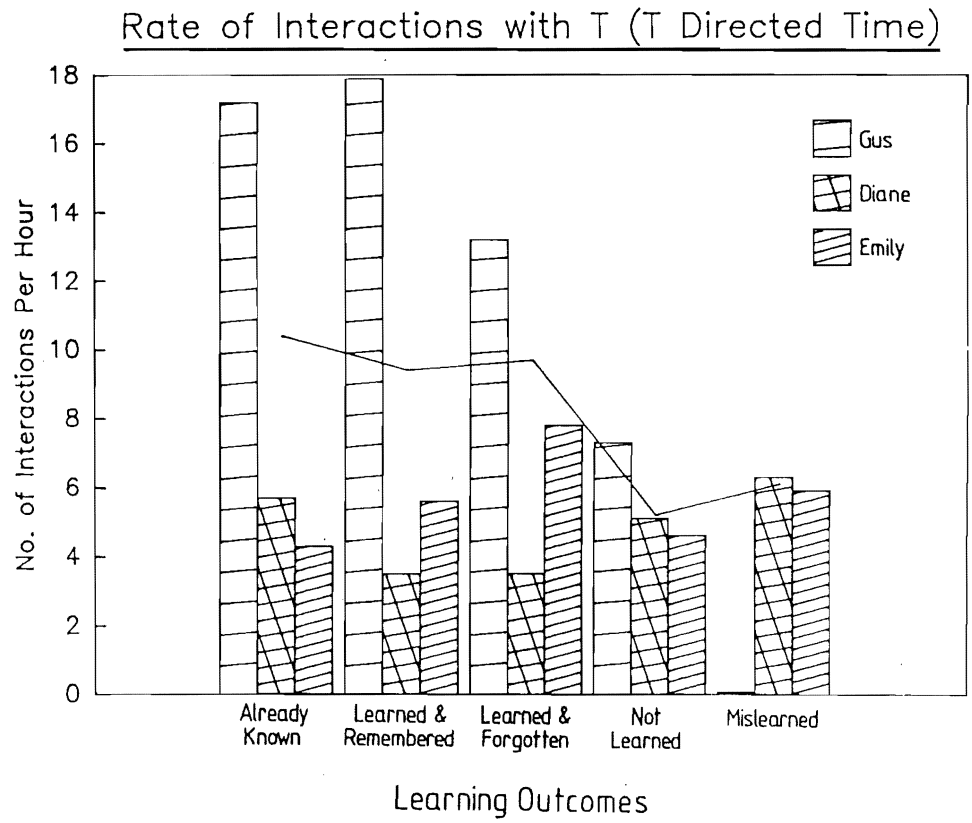


Figure 39



Gus's individual interactions with T generally involved him giving a corrrect response. On one occasion the observer noted that T appeared to depend upon Gus to give answers when other pupils were unable to provide an appropriate response. Unlike Diane and Emily Gus frequently asked T questions, or asked for further clarification of an issue. His interview responses revealed that he perceived interacting individually with T during teacher-directed lessons to be important to his learning. On occasions Gus would interrupt the flow of the lesson and insistently pursue a line of inquiry even when T was reluctant to extrapolate. He did not appear to be unduly concerned when he gave an incorrect response, but expected T to help him understand the material when this happened:

> If I don't know something I can easily ask the teacher.

> If you get asked a question and you get it wrong then you get the proper answer and you try to remember it - or you learn it at home.

By contrast Diane and Emily never asked questions of T and frequently gave incorrect responses when called upon to respond. From time to time T would ask Diane or Emily to participate in the lessons. For example:

> Emily, think! You still haven't thought of an answer. You should be thinking all the time.

Although more actual individual interactions with T occurred during the time spent on learned content for all three case study pupils (see Figure 38) the rate of interactions per hour showed varying relationships with case study pupil learning. As can be seen in Figure 39, Diane engaged in higher rates of interactions per hour about content which she mislearned and failed to learn. The high number of interactions with T associated with content which Diane mislearned was an unexpected result. Much of the research on teacher effectiveness has involved assumptions that pupil interactions with teachers facilitate learning (for example, Maltby, 1983). An examination of Diane's interactions with T about the aeroplane as a cause of pollution provides an insight into this result. On Day 13, T divided the class into two groups for a language activity. Each group member had to call out an adjective to describe polluted or unpolluted air. The activity was organized as a competition between the two groups and was teacher-directed. When her turn came, Diane called out 'aeroplane'. T pointed out that aeroplane was incorrect but Diane apparently did not realize that T was excluding her response for grammatical reasons rather than content-related reasons. On two more occasions during the lesson T disqualified similar inappropriate responses and referred back to Diane's error:

> Oh, but I've given you second chances, like Diane's one with 'aeroplanes'...
>
> Can't take plants because I should have taken her 'aeroplanes'.

Table 24

Reliability Estimates for Non-Passive Pupil Behaviours Which Occurred During Teacher-Directed Lessons

	Overall		Gus		Diane		Emily	
Behaviour	Mean	Rate	Mean	Rate	Mean	Rate	Mean	Rate
Interactions with Teacher	0.74	0.94	0.86	0.84	0.00	0.00	0.00	0.72
Hand Raises	0.91	0.37	0.70	0.64	0.96	0.00	0.73	0.88
Chorus Responses	0.89	0.00	0.95	0.00	0.00	0.00	0.97	0.37
Talking to Self	0.59	0.00	0.54	0.00	0.65	0.44	0.95	0.00
Interactions with Peers	0.76	0.71	0.53	0.70	0.53	0.69	0.89	0.69
Non-verbal interactions with Peers	0.55	0.87	0.78	0.53	0.00	0.00	0.23	0.56
Fiddling	0.62	0.00	0.21	0.00	0.70	0.00	0.44	0.76
Incidental Mime	0.39	0.52	0.48	0.00	0.00	0.00	0.28	0.20

It seems that other class members misinterpreted the task in the same way as Diane. T's interaction with Diane, however, served to change her view that aeroplanes cause pollution. A year later in the interview, her mislearning that aeroplanes do not cause pollution was still shown to be a strong belief.

It is apparent in Table 22 that Gus engaged in far more individual interactions with T during the time spent on learned content than either Diane or Emily His mean total of interactions with T for items learned and remembered is over four times as high as Emily's and over five times Diane's.

All three pupils engaged in relatively infrequent interactions with T about content which was not learned.

Figure 39 showing rates of case study pupil interactions with T per hour clearly depicts individual pupil patterns. Gus engaged in a rate of interactions of between 13 and 18 per hour during the time spent on content he learned. He engaged in less than half this rate of individual interactions with T per hour for content which he failed to learn.

Gus's rate of 7.3 interactions with T per hour during the time spent on content which was not learned is higher than the rate of interactions with T engaged in by either Diane or Emily during the time they spent on learned content. These results suggests that Gus had a more active learning style during teacher-directed lessons than either Diane or Emily. His attitudes toward individual interactions with T seem to have enabled him to use these opportunities to clarify issues which he found confusing and to initiate independent follow-up action to expand upon these concepts.

The strong relationship between Gus's interactions with T and his learning shows him to be an exception in relation to Hughes' (1973) finding with seventh grade pupils that overt responding was not a strong variable in relation to pupil achievement. Brophy and Evertson (1974) reported a positive correlation between pupil call outs and pupil achievement in second and third grade children in low SES classes which is consistent with this finding in a mixed SES class.

9.4.2 Hand raises

Generally pupils in T's class raised their hands to indicate they wanted to respond to a content-relevant question asked by T. For example, hand raises occurred in response to these kinds of questions:

T What's happening to each grain of sand?

T Can you explain how waves cause erosion?

T What part of the cycle can we actually make use of?

However, T also asked the children, from time to time, to raise their hands in order to indicate to him whether they had prior experiences relevant to the content under discussion:

T How many of you have visited the Waimakariri River?

Figure 40

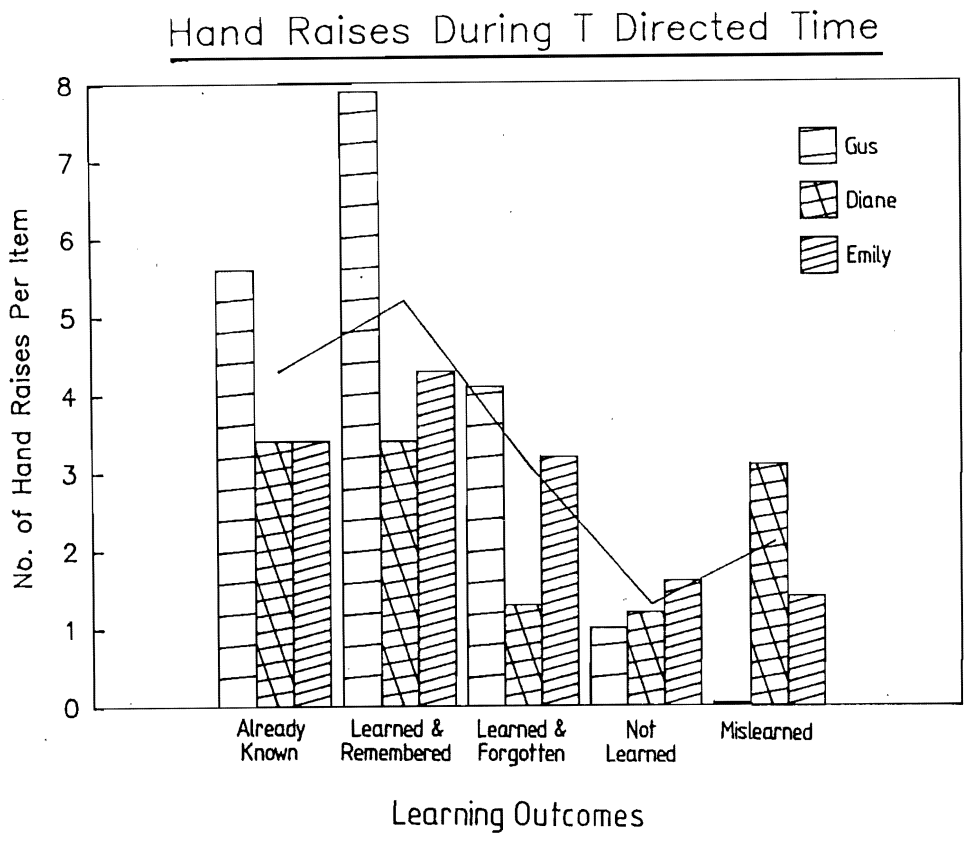
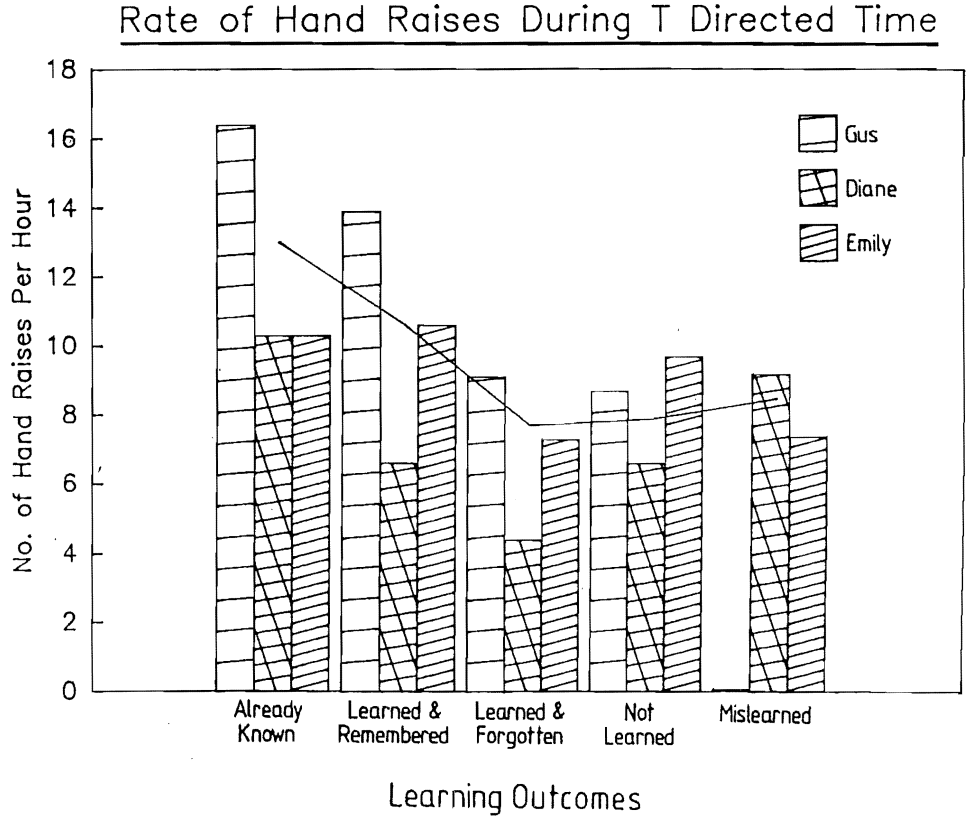


Figure 41



T How many of you have been over to West Coast over to Arthur's Pass?

T Tell me, who has been to the Ashley Gorge for a picnic?

It can be seen in Figure 40 that more hand raises occurred during the time spent on content which was learned than that spent on content which was not learned. This pattern was consistent across all three data sets for all three pupils. The overall reliability coefficient is r = 0.91. Again, however, Gus engaged in more hand raising than either Diane or Emily. All three pupils raised their hands fewer than twice per item on average, during the time spent on content which was not learned.

In Figure 41 it can be seen that Gus engaged in higher rates of hand raising during the time spent on content which he learned and remembered and Diane engaged in higher rates of hand raising during the time spent on content which she already knew or mislearned. Emily's hand raising rate was fairly standard at about eight to ten raises per hour. The lower rates of hand raising behaviour which occurred for content which was learned and forgotten are consistent with the pattern of higher rates of teacher-only talk about this content. As can be seen in Table 24 the rate of hand raising behaviour for both Gus and Emily was highly consistent across the three data sets. However, Diane's hand raising behaviour showed no consistency.

It can be seen in Table 22 that Diane and Emily raised their hands more frequently than they engaged in public individual interactions with T while Gus engaged in fewer hand raises than individual interactions with T. Thus not only were there differences between the case

study pupils in the level of overt responding in which they engaged but also Gus was more likely to respond verbally than non-verbally to ongoing public talk in contrast to Diane and Emily.

9.4.3 Talking to Self

Dramatic differences between the case study pupil patterns of talking to self behaviour are apparent in Figure 42. Gus talked to himself considerably more than either Diane or Emily, and his talking to self behaviour was strongly and consistently ($r = 0.54$) related to his learning. Emily's slightly higher numbers of talking to self events during the time spent on content which she learned and forgot showed a consistent pattern across the three data sets ($r = 0.95$). By contrast Diane engaged in slightly lower numbers of talking to self events during the time spent on content which she learned and forgot. This pattern was consistent for Diane ($r = 0.65$).

The results for rates of talking to self behaviour shown in Figure 43 indicate that although Gus's and Emily's rates were fairly similar across learning conditions Diane's rates were highest for items she already knew, items she failed to learn and items she mislearned. However, the results for <u>rates</u> of talking to self behaviour were inconsistent across the three data sets (Table 24).

The observer comments about case study pupil talking to self behaviour shed further light on these results. On Day 5 of the unit the observer noted of Gus:

Figure 42

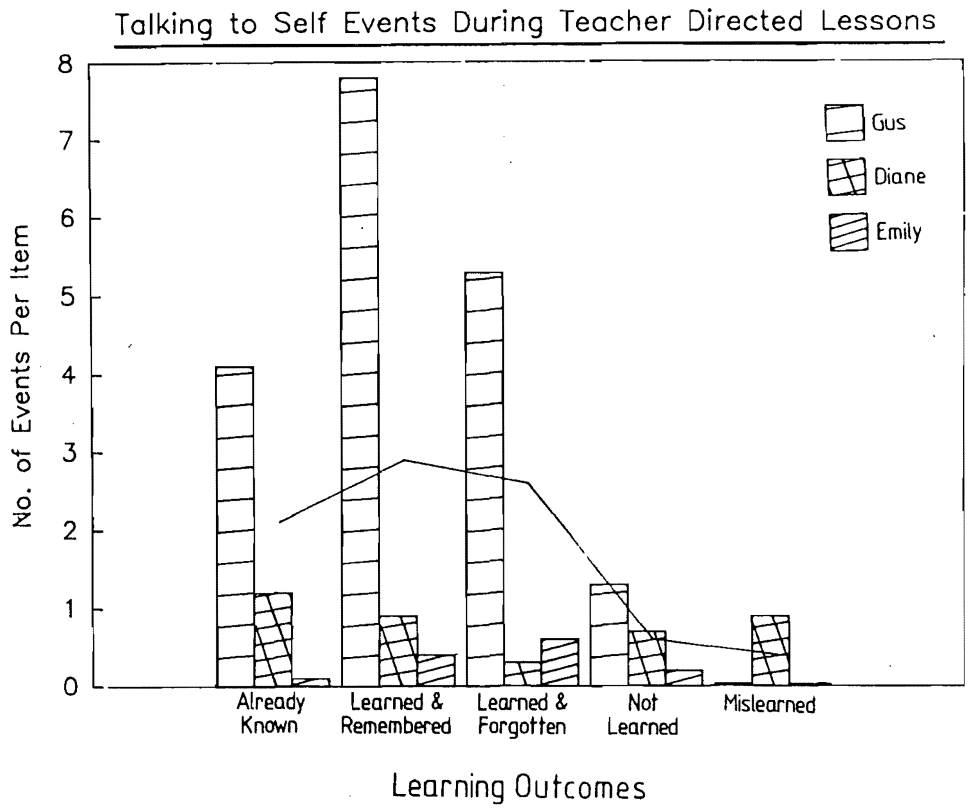
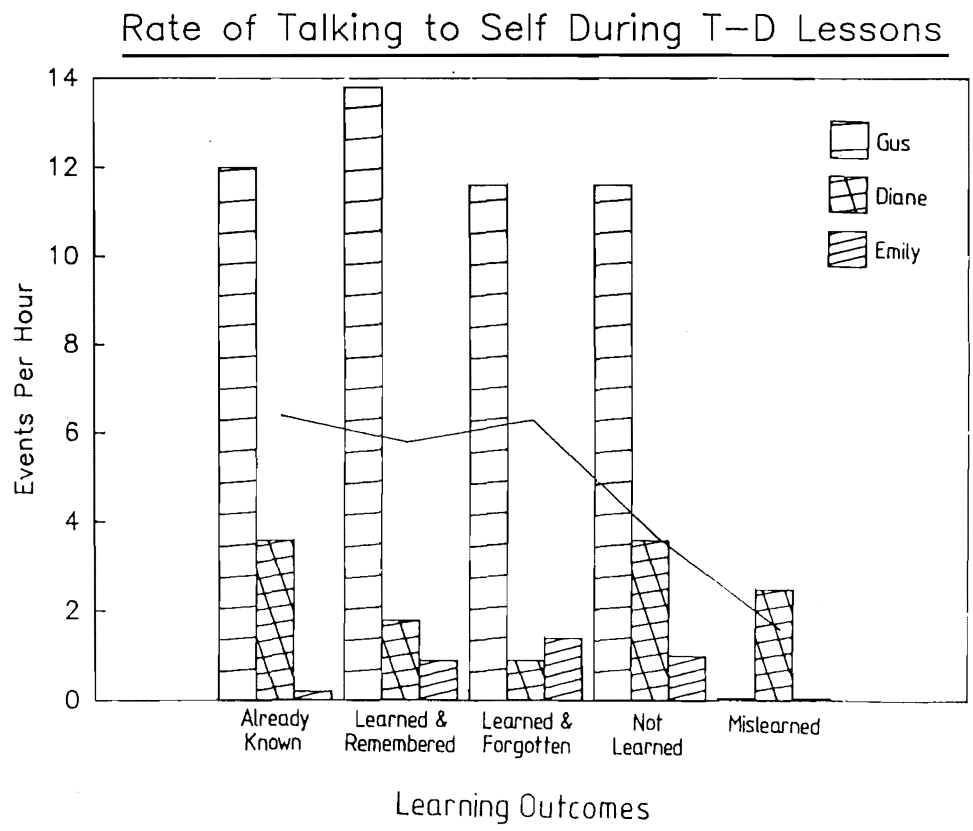


Figure 43



> All through the lesson Gus talked to himself - generally in response to T's queries etc. He answered to himself, and in some cases appeared to anticipate T's question. All this verbalization appeared to be on task.

Observer notes about the much rarer instance of Diane talking to herself suggest a different kind of function in her behaviour:

> ...tries an answer to self under her breath...

It seemed as though Diane was practising responses of which she was uncertain. The observers noted that Emily also seemed to be practising responses under her breath rather than responding publicly. On one occasion Emily was observed to raise her hand in response to T's question, lower her hand, and then mouth the response under her breath. This kind of semi-covert responding was associated with pupil learning.

9.4.4 Chorus Responses

Typically chorus responses involved the children calling out in unison 'Yes!' or 'No!' to a question posed by T. For example:

T	Is the sand moving?
Pupils	Yes!

A further example is apparent in this discussion about endangered animals:

T	Right. They just go around hitting them on the head with clubs. Do they make use of them?
Pupils	No!
Pupil	Just the skins.
T	Right. They make very little use of them.

Figure 44

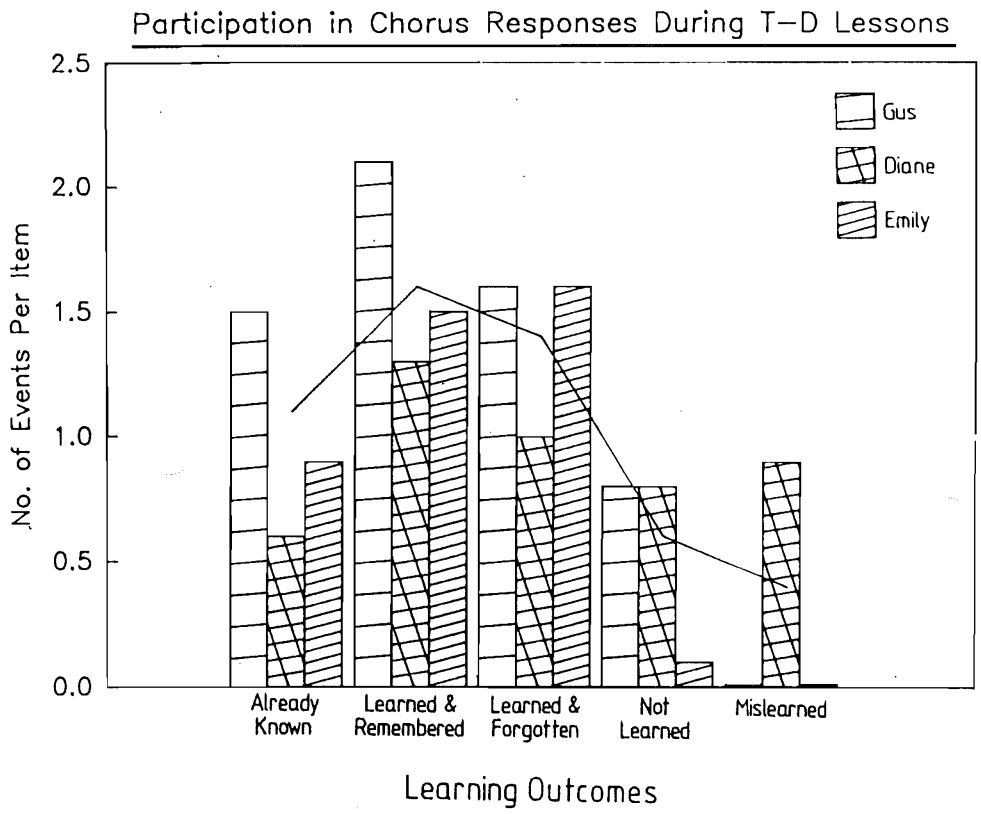
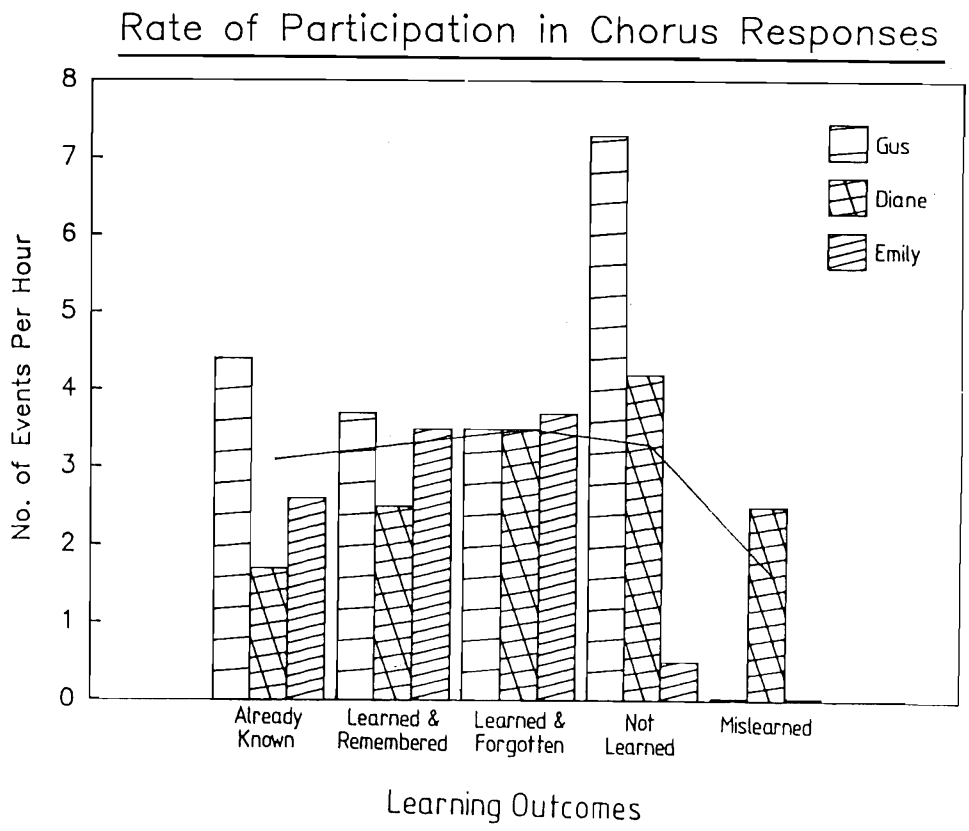


Figure 45



Occasionally T would ask the children to read blackboard or chart material in unison. For example, in the following excerpt T was attempting to ensure that the pupils were pronouncing 'deforestation' correctly:

T	Yes. It's more like 'tion' ('shone'). Actually it should be 't-i-o-n', but you don't actually pronounce it as that. Right. Say the words all together.
Pupils	Forestation! Deforestation! Civilization!
T	Stop! I can still hear people saying 't-i-o-n'. What's that sound at the end?

As can be seen in Figure 44 the mean numbers of chorus responses in which the pupils participated were higher during the time spent on learned content at about one to two chorus responses on average, per item. Few chorus responses occurred for items not learned or mislearned. These results were highly consistent for Gus (r = 0.95) and Emily (r = 0.97) but inconsistent across the three data sets for Diane (0.0).

The rates of chorus response participations showed no particular pattern except for items Emily failed to learn which rarely involved chorus responses.(See Figure 45). This suggests that chorus responses did not facilitate learning independently of time spent. These rates were inconsistent across the three data

sets.

9.4.5 Fiddling

The category of 'fiddling' events included events such as pupil fiddling with a ruler, pencil, piece of paper, or article of clothing. The overall pattern of pupil fiddling during teacher-directed lessons in relation to learning is shown in Figure 46. The highest numbers of fiddling events occurred for all three pupils for items they learned and forgot. (See Table 18). That is, the most fiddling events occurred during teacher-directed time spent on content which was learned and forgotten in spite of the fact that less time was spent on this content than was spent on content learned and remembered. The second highest numbers of fiddling events occurred for items the pupils learned and remembered. High numbers of fiddling events occurred for items Diane and Emily mislearned and the least fiddling events occurred for items not learned.

The findings on rate of fiddling events per hour (see Figure 47) show that the highest overall rate of fiddling occurred for items learned and forgotten and items mislearned. Gus engaged in the highest rate of fiddling for items he failed to learn.

In summary, more actual fiddling and higher rates of fiddling behaviour occurred for items learned and forgotten. This is a result which indicates that fiddling may be a behavioural signal of certain kinds of mental processing as both short-term learning and mislearning involved pupil concept changes. However, T believed fiddling to be a sign that pupils were not interacting with relevant content, as reflected in his comment to the researcher on Day 14 of the unit:

Figure 46

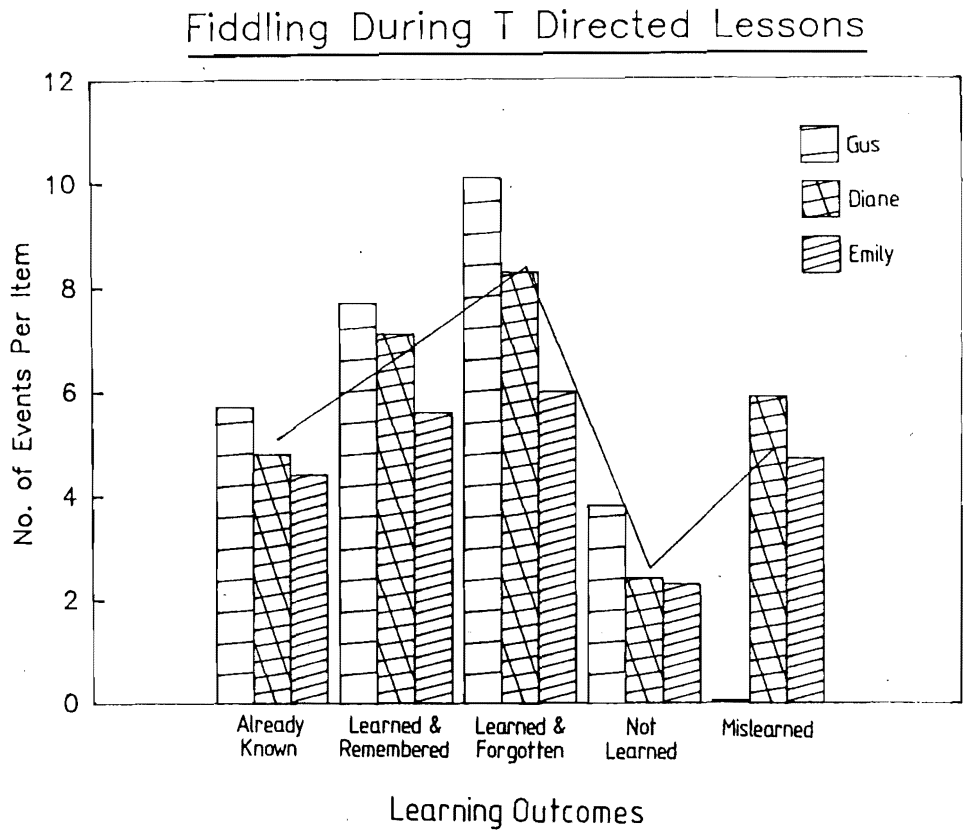
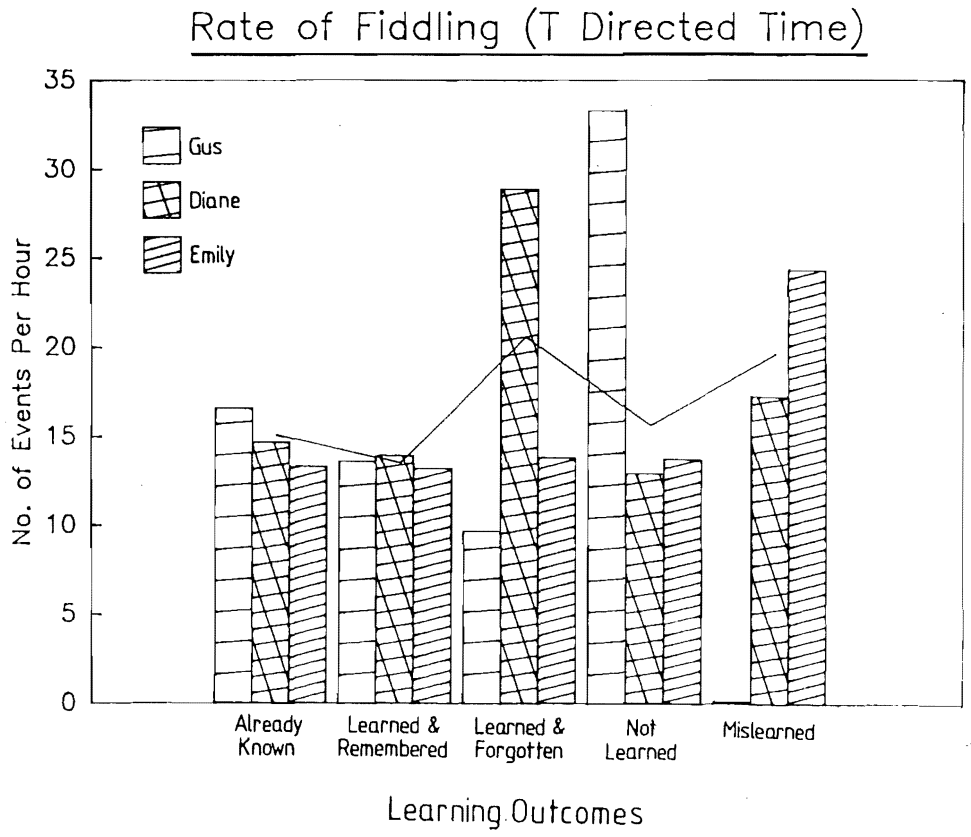


Figure 47



> ...boys who don't get involved
> they just sit and fiddle and
> don't get much out of the discussion.

The higher occurrence of fiddling during teacher-directed time spent on content learned and forgotten may relate to the high rates of teacher-only talk which occurred during this time.

However, the high rates of fiddling which both Diane and Emily engaged in for items they mislearned suggests a different interpretation of these results; that fiddling behaviour occurred as a result of cognitive conflict the children experienced trying to accommodate to contradictory content (items mislearned) or content unrelated to the children's own experience (items learned and forgotten). This interpretation is argued in more depth in Chapter 12 in relation to the high rate of fiddling which occurred during teacher-directed talk about content relevant to items for which the least class time was spent.

9.4.6 Peer Interactions

As can be seen in Figure 48 all three pupils engaged in more peer interactions for items they learned than for items that they did not learn. Generally, Gus engaged in about four to five times as many verbal interactions with peers as the two girls. Diane engaged in her highest average number of peer interactions (four) about content she learned and remembered. However, Gus and Emily engaged in their highest numbers of peer interactions about content they learned and forgot.

Figure 48

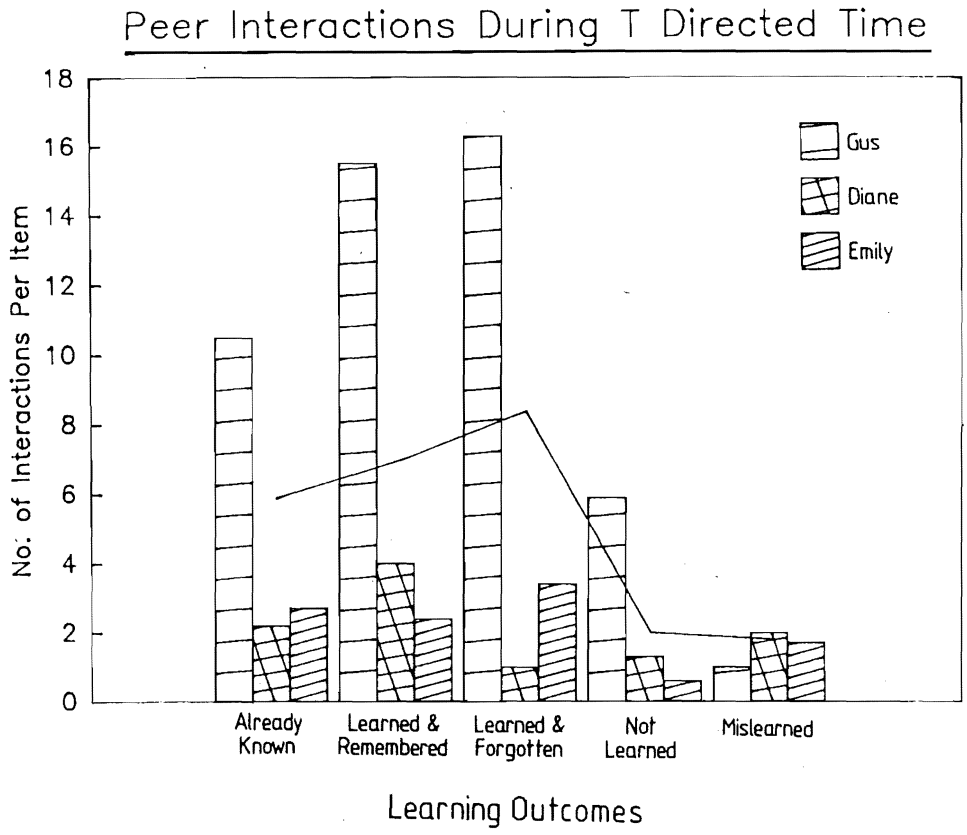
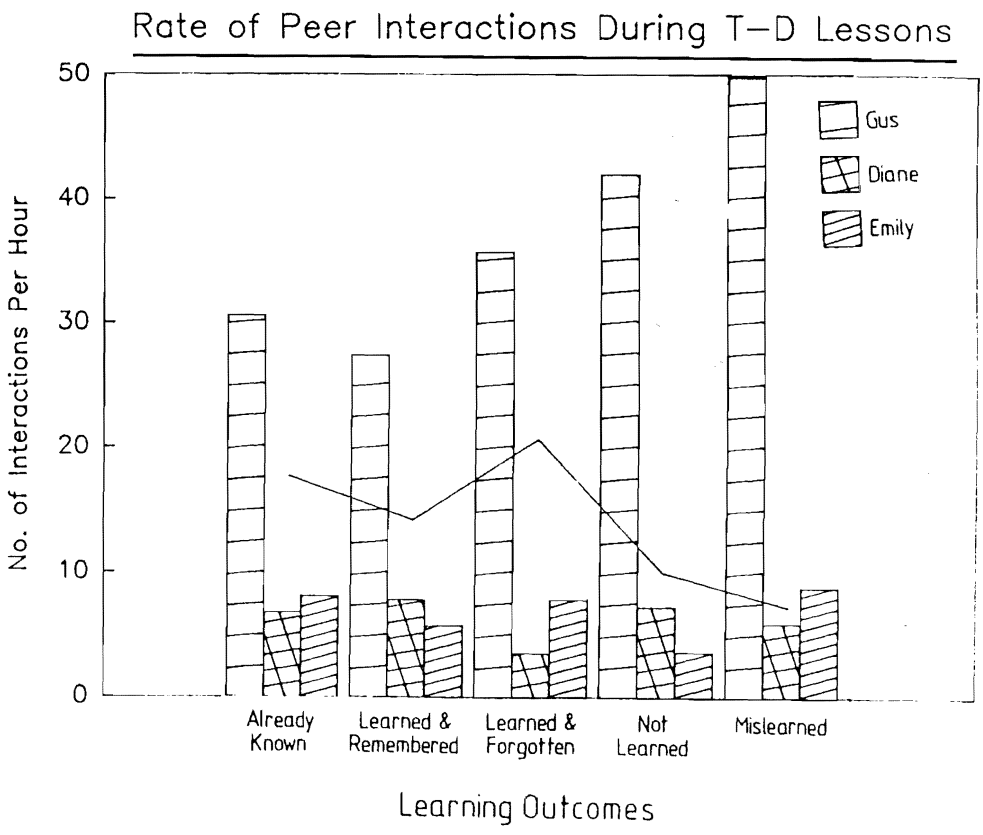


Figure 49



Both Diane and Emily engaged in higher rates (one peer interaction every seven to ten minutes) for items they learned and remembered than they did for content they failed to learn (Table 23 and Figure 49). On the other hand, Gus's lowest rate of peer interactions occurred for content he learned and remembered (one interaction every two minutes) while his highest rate (one interaction per minute) was associated with items he did not learn.

The results for Diane and Emily are surprising because, in traditional research, pupil interactions during teacher-directed lessons would be categorized as off-task. In this study very high rates of almost one interaction per minute were related to failure to learn. However, both total amount of interaction and higher rates of interaction with peers showed positive relationships with learning for Diane and Emily, and Gus engaged in more than one peer interaction every three minutes for content he learned and remembered one year later. Although it was generally impossible to overhear these interactions it was apparent, at times, that the pupils were sharing relevant experiences about the issues under discussion. Frequently such sharing involved muffled giggles. Most of these peer interactions appeared to involve the pupils sharing responses to T's questions with each other, when frustrated because he was not calling on them to give a public response.

Some peer interactions were unrelated to the content under discussion. On Day 4 T reprimanded Gus and his neighbour for talking during the lesson and required them both to write public apologies. Gus wrote:

> To Mr H and Dl,
> This morning I was talking to
> Crane but I didn't like the

game and I couldn't hear the questions that the people were asking and I couldn't think of anything else to do so we were talking about the holidays.

T's response to Gus's public reading of his apology showed his strong view that peer interactions were unacceptable:

T I wonder why you couldn't hear the questions?

P Because they were talking.

T So anything you're not interested in you will spoil for everyone else. Well, that sounds pretty good and selfish doesn't it? ...Is that reasonable...?

Gus Yes, No...Ah...

P I don't know.

T You don't know. Do you think you might say something if we all started doing that to you. I'm quite sure you would. Yes, you wouldn't think it was very fair at all. Well, I don't think it was very fair that you were interrupting others. If you didn't want to join in the game, you've been told before go and sit down and read or do

> something quietly and don't
> interrupt the ones who are trying
> to do something.

T's attitude to this peer discussion which was unrelated to lesson content was clearly negative. However, T either failed to register or did not mind content-relevant peer discussions which occurred frequently, particularly during guided silent reading lessons.

The positive relationship between much of the peer discussion and pupil learning suggests a need to gain more information about the content of informal pupil interactions during teacher-directed lessons.

Cosson (1978) found pupil peer interactions to be associated with gains in expressive language in special class (mildly-retarded) children as measured by the Peabody Picture Vocabulary Test. Johnson (1981) pointed out that student-student interaction has been a neglected variable in educational research and Cazden (1983) has also called for more investigation of peer discourse.

9.4.7 Non-Verbal Pupil Interactions

It was very difficult to interpret the meaning of non-verbal peer interactions. However, this category included laughing about shared peer jokes and apparently functional interactions such as signals used by the case study pupils when requesting other pupils to move out of their line of vision.

Figure 50

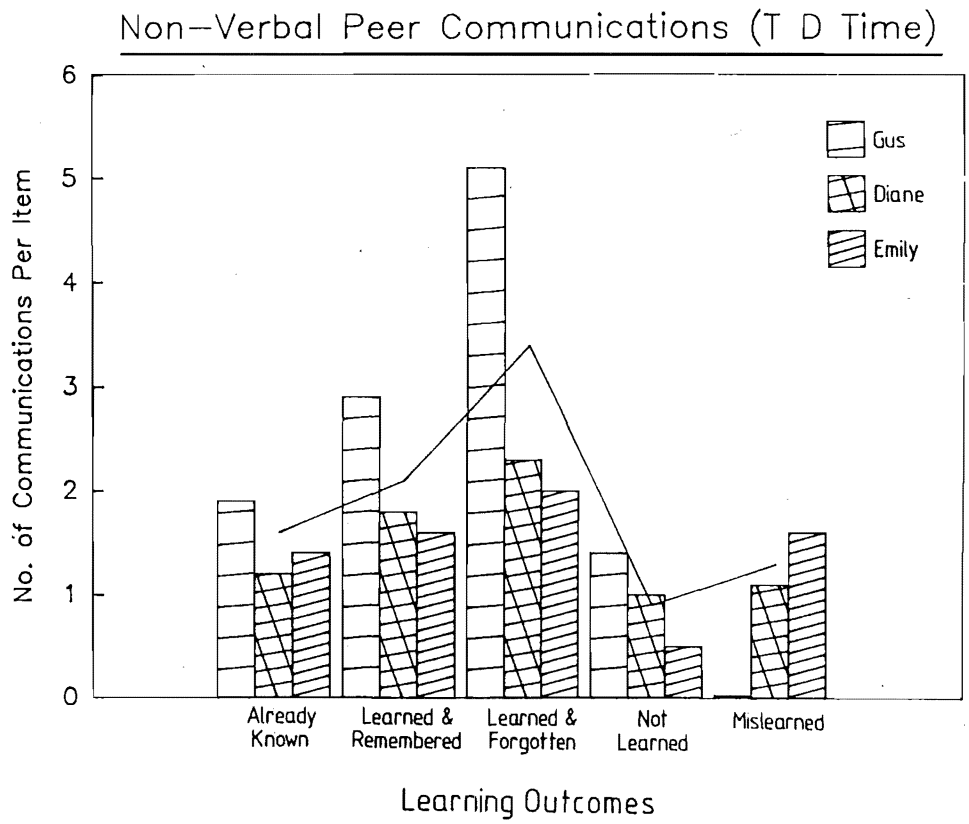
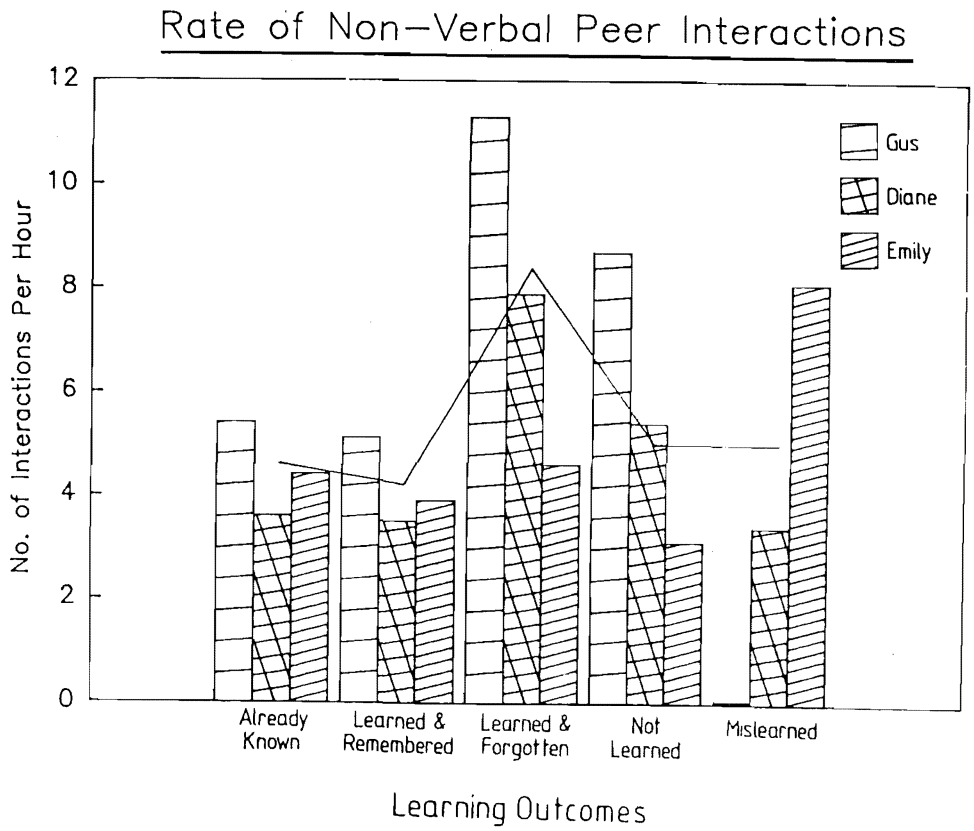


Figure 51



As can be seen in Figure 50 all three pupils engaged in most non-verbal interactions with peers during the time spent on content which was learned and forgotten. Thus non-verbal peer interactions were associated with short-term learning outcomes. It is apparent in Table 22 that two to three non-verbal peer interactions occurred, on average, for items learned and remembered and about one occurred for items not learned.

The highest rate of non-verbal peer interactions also occurred in relation to content which was learned and forgotten (Figure 51). The association of higher rates of non-verbal interactions with content which was either learned or forgotten or mislearned indicates that this behaviour may have been, in some cases, be an observable concomitant of certain kinds of mental processing associated with content which involved misconceptions (see Chapter 12).

It is plausible that peer joke sharing involved the pupils in recognizing incongruities in new content. This kind of behaviour may indicate a functional response to content which gives rise to conceptual conflict. Cazden (1983) called for investigations of humour in classrooms. Those researchers who have investigated humour (Walker & Goodson, 1977) have taken a sociological focus; they have not addressed the possibility that pupil humour can be facilitative of learning.

9.4.8 Informal Mime

Informal mime events involved the children acting out concepts and ideas that were discussed during teacher-directed lessons. For example, during the discussion of the aeroplane as a pollutant, Gus acted out a sequence of being an aeroplane. When T spoke of looking into the past Gus pretended to be using binoculars. Diane and Emily also engaged in informal mime, acting out the process of fish dying in polluted water and birds suffocating in polluted air during T's reading of 'The Lorax' and 'The Sknuks'. At times T would respond to spontaneous pupil mime by encouraging all the pupils to act out the idea.

As shown in Figures 52 and 53 more of this behaviour occurred for content which was learned and forgotten and a higher rate of informal mime also occurred in relation to this content. The association of informal mime with content learned and forgotten parallels the pattern for teacher-directed mime. However, unlike the pattern for teacher-directed mime some informal mime occurred for content which was not learned. Although the overall pattern mime occurrence related to short-term learning for all three pupils these results were inconsistent across data sets (see Table 24) and informal mime appeared to occur only in relation to specific content.

The overall pattern of high rates of mime during class time spent on content which was learned and forgotten, like the results for fiddling and non-verbal peer communications suggests that pupil response to this content was different to that shown in response to content which was learned and remembered.

Figure 52

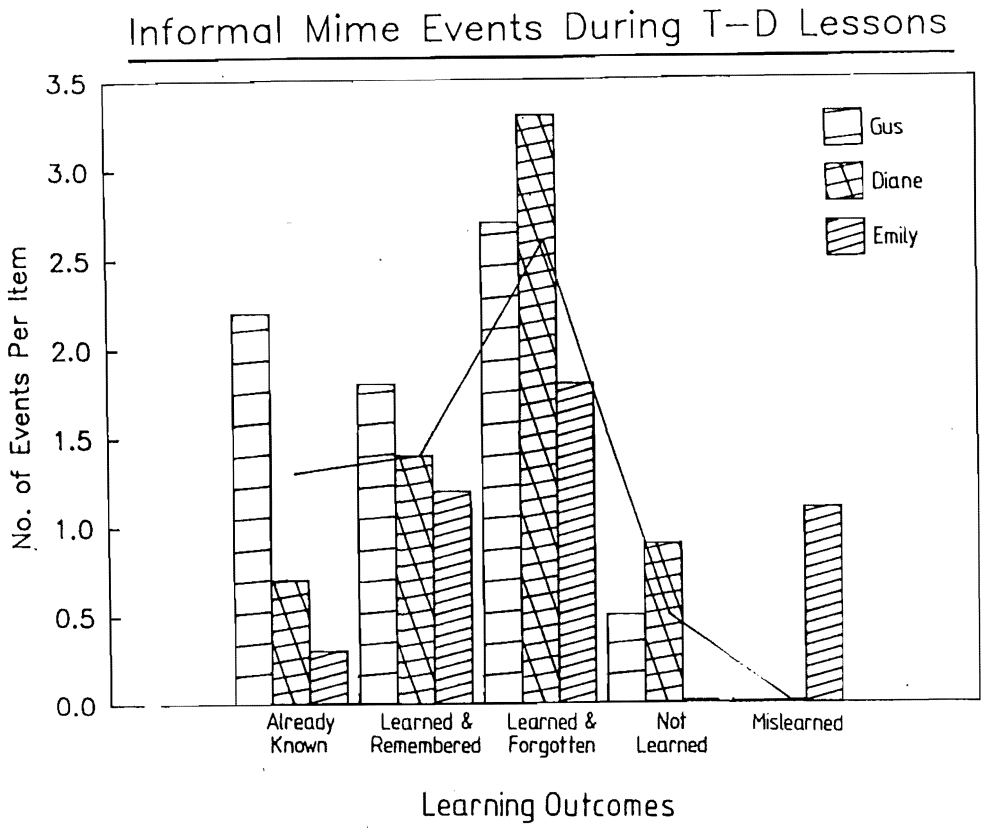
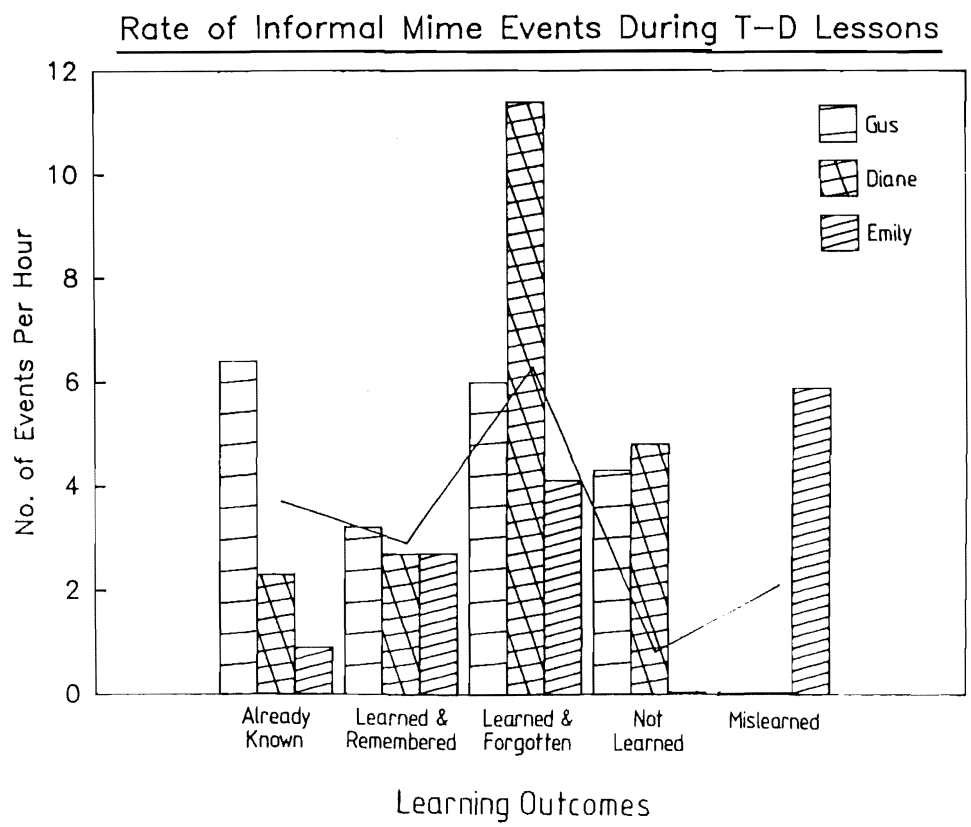


Figure 53



9.4.9 Summary of Non-Passive Pupil Behaviours During Teacher-Directed Lessons in Relation to Pupil Learning

Public participation in teacher-directed lessons (individual interactions with T, hand raises, chorus responses) was systematically related to pupil learning although pupils varied in their rates of public involvement. There were, however, differences between the case study pupils in the behavioural patterns associated with learning. Higher rates of interaction with T occurred in relation to content Diane mislearned and failed to learn. Gus engaged in many more, and a higher rate of, overt behaviours than either Diane or Emily. Further, some of his behaviours were qualitatively different in that he was more likely to give a correct response to T and he was more likely to initiate discussion of content than either Diane or Emily. Like both Diane and Emily, however, Gus developed misconceptions about which he appeared to become confused during teacher-directed lessons.

Informal verbal peer interactions did occur during time spent on content which was learned, however, a ceiling level seemed to have operated at more than one interaction every two minutes.

Behaviours such as fiddling, non-verbal peer communications and informal mime were more frequent during the time spent on content which was learned and forgotten.

The relationship between peer interactions and learning and fiddling and learning raise questions about the validity of assuming such behaviours to be off-task (Beardsley, 1979; Berliner and Rosenshine, 1978). These results also raise interesting questions about the kind of observable and unobservable processes which

facilitate learning during teacher-directed lessons.

In Chapter 12 those behaviours which occurred at very high rates during exceptionally effective learning conditions are identified, and in Chapter 13, a summary and a perspective is provided of those behaviours and opportunities which were consistently associated with pupil outcomes.